Studies on
THE INCIDENCE OF BOVINE UROLITHIASIS
AND ITS SURGICAL APPROACH UNDER
FIELD CONDITION WITH
SPECIAL REFERENCE
TO
INDWELLING POLYTHENE CATHETER

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Dedicated

To

my

Revered Teacher

S. A. AHMED

whose silence signifies

and guidance glorifies.
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(C. A. BHATT)
## Contents

<table>
<thead>
<tr>
<th>Chapter</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Introduction</td>
<td>1 - 8</td>
</tr>
<tr>
<td>II. Review of Literature</td>
<td>9 - 36</td>
</tr>
<tr>
<td>III. Survey of Incidence</td>
<td>37 - 51</td>
</tr>
<tr>
<td>Materials &amp; Methods</td>
<td>37 - 40</td>
</tr>
<tr>
<td>Observation &amp; Results</td>
<td>40 - 46</td>
</tr>
<tr>
<td>Discussion</td>
<td>47 - 51</td>
</tr>
<tr>
<td>IV. Anatomy of Bovine male Urethra &amp; Penis</td>
<td>52 - 60</td>
</tr>
<tr>
<td>V. Materials &amp; Methods</td>
<td>61 - 72</td>
</tr>
<tr>
<td>VI. Observation &amp; Results</td>
<td>73 - 84</td>
</tr>
<tr>
<td>VII. Discussion</td>
<td>85 - 93</td>
</tr>
<tr>
<td>VIII. Summary</td>
<td>94 - 96</td>
</tr>
<tr>
<td>IX. References</td>
<td>1 - xiv</td>
</tr>
</tbody>
</table>

Number of Photographs: 42
Number of Graphs: 3
Number of Figures: 1
Number of Map: 1
INTRODUCTION
Perhaps next to malignancy, urolithiasis presents one of the most difficult problems confronting Urologists.

Urolithiasis in livestock constitutes a major problem of considerable importance in veterinary practice. Equally important is the problem of successful urethrotomy in bovines, a surgical approach for urethral calculosis obstructing urinary passage and causing retention of urine with rupture either of urethra or bladder resulting in urinoma and death. The treatment of urethral calculi is principally a surgical one, both as a palliative as well as curative. The condition requires immediate surgical intervention for removal of the obstruction and making the urethral canal free for the natural flow of urine. Urethrotomy is an important and a common operation encountered very frequently in veterinary practice in several states of India. Successful urethrotomy relieves the sufferings of the ailing animals and render them useful, may they be male calves, working bullocks or breeding bulls. It thus brings immediate economic benefits to the hard pressed livestock owners.

Urolithiasis and urethrotomy in cattle have not drawn as much attention of investigators and research workers to the extent it warrants. This may be perhaps be due to the
fact that the veterinarians are largely preoccupied in count-
eracting the epizootics and other animal husbandry aspects,
affecting livestock. In other countries, considerable work
has been done on the problem of urolithiasis in farm animals,
particularly in the field of animal nutrition in relation to
mineral metabolism.

Urolithiasis may be defined as concretions formed
of urinary crystalloids bound together by and incorporated in
a colloidal matrix. Urinary calculi are almost composed of
substances normally excreted in urine, together with certain
amount of protein materials. Bovine urinary calculi are gene-
really formed of protein, silica, calcium oxalate, carbonates
of calcium and magnesium and phosphates of calcium. Thus it
is the deposition and solidification of crystalline materials-
the inorganic constituents of urine. These calculi form an
obstacle to free flow of urine, when stuck into the narrow
urinary passage. Urethral calculi are generally those escaped
from bladder and cause obstruction in the urethra. It is an
important condition affecting male ruminants.

The incidence of urolithiasis in these species are
directly related to the anatomical features of the penis and
urethra. The most unique feature is their anatomical disposition
into sigmoid flexure. The other specific factors favouring
urethral obstruction are, the narrow urethral lumen still narro-
wing from behind forward, less elastic tissue in the mass of
penis and the rigid and fibrous tunica albuginea, paving the floor of urethral groove, limiting the dilatation of the urethra.

These features have not only made ruminant urethral surgery a difficult task, but also offered a well nay impossible barrier to the passage of the catheter.

The report of Bristol et al. (1961) state that the history of urolithiasis dates back to 1880 A.D. Economic losses due to this condition in cattle is significant. It occurs in all species of animals, but it is most common in cattle and sheep. The condition is also fairly common in canine and feline species and comparatively rare in equines. Factors like age, sex, skin texture, genetical make up, hormonal imbalance, soil, season, geographical districts, hydrophilic colloids, feeds, fodder, vitamins, water, minerals, infection and stress are all said to play in etiology to a smaller or greater extent.

Causes of urethral obstruction, in addition to urinary calculi are urethritis, urethral spasm and stricture or stenosis.

Obstruction is manifested clinically by retention of urine, and subsequent syndrome of obstructive renal colic.

The sequelae of urethral obstruction are perforation and rupture of either urethra or bladder which generally proves fatal. Some times, over distention of bladder results
in bladder paralysis (Coelune and Tillmann, 1965).

It is time to take up every important surgical affection of cattle from economic and production point of view as they directly affect the welfare of livestock owners at large. Veterinarians throughout India face problem of saving valuable bullocks suffering from urethral calculi. Such animals are generally quite healthy otherwise. If by surgical interference the obstruction is removed in time, recovery is without any evitable complications and the animal become useful again in short time.

In the fast changing socio-economic circumstances, the farmers do expect from the 'Vets' - the custodians of livestock - a sincere effort to prevent or avert the drainage of his purse, and hence the necessity to solve the problem, by evolving suitable method for the treatment of bovine urethral calculosis.

The high incidence of obstructive urolithiasis requiring urethrotomy operation lead the list of conditions demanding modified surgical techniques which are yet to be evolved.

Jhanson et al. (1940) reported a 10 % loss due to urinary calculosis in bovines. Sinha (1952) stated that urolithiasis in bovine ranked among the items of animal diseases requiring investigations in Bihar. Swingle (1953) considered the condition of urethral calculi as responsible for considerable loss. Dutta et al. (1969) drew attention towards the
serious nature of losses due to urinary calculosis in live-
stock. Pool (1960) stated that urinary calculosis ranked
fifth in the category in U.S.A. and Canada. Howkins (1965)
indicated 3% mortality in calves due to urolithiasis.

The above statements give an idea of the importance
of the condition.

The approach to the medical or surgical treatment
of urolithiasis is dependent upon accurate and definitive
diagnosis.

Medicinal treatment in cases of complete obstruc-
tion due to solid calculi has little place in bovine urethral
calculosis, sequelae being uraemia, rupture of bladder or
perforation of urethra. The therapeutic treatment if at all
resorted to in very early cases showing preliminary symptoms
may be helpful and of value.

However, importance of medicinal treatment in uro-
lithiasis has been stressed in human medicine. There, the
trend of research has been directed towards attempts to dis-
integrate and decrease the concretion of crystalline material.
Such therapeutic measures have not so far proved completely
successful except in correcting certain metabolic disturbances,
like supply of balanced mineral ration, vitamine A and ade-
quate quantity of drinking water.

The surgical approach by urethrotomy and removal
of stone is the most common practice in treating urethral
calculi in bovine. All Veterinary Surgeons from Fleming of the old faculty to Frank of the fifties and from Carey to Kiesal and Kopper of the sixties have fostered this technique with modifications of modern manoeuvre.

Different sites and modifications in urethrotomy operation have been practised with varying results of success. At present, in India, post scrotal urethrotomy generally without suturing the urethra is in vogue. The second site of preference is the ischial urethrotomy, a surgical intervention practised from the time of Clater’s Doctor of cattle, because of its immediate result of relieving bladder distention. The prescrotal operation is also performed at the discretion of the Surgeons, if and when required.

Surgeons like Wooldridge, Wheat, Gibbons, Perliska, Jackson, Hasting, Frank and Saythe have recommended urethrotomy with exteriorisation of urethra in the perineal region, generally with amputation of the penis. This is more suitable for steers which are maintained up to the completion of fattening period. This is not practised in India where circumstances are quite different. Here the purpose and aim of the operation is to increase the longevity of the animal for agricultural operation and other transport purposes.

With the present technique of urethrotomy in practice, it is experienced that the percentage of success in surgical approach to bovine urethral calculi is far from
satisfactory. The Veterinary Surgeons are rather conscious of this less rewarding aspect of bovine surgery for the following unfavourable factors.

(a) Multiple calculi in urethra or bladder (Wooldridge and Oelune).

(b) Urine infiltration of tissues surrounding the incision with subsequent necrosis, gangrene and sloughing (Subbarayalu, Sambasurthi, Desman, Smythe, and Metcalf).

(c) Sepsis - Urinary abscess and stricture causing recurrence (Meat).

(d) Absence of availability of proper facilities for diagnosing and locating the exact site of obstruction.

(e) Obstruction in the pelvic urethra or the neck of the bladder.

(f) Wound contamination by urine and associated conditions which delay or retard healing.

The recent trend to achieve better results in urethral surgery has been ad hoc attempts, to prevent some of the above mentioned controllable factors only.

The catheter - a urinary prosthesis - has played an important role in the modern research of urethral surgery. Human and Veterinary Surgeons have freely used it in modifying the techniques. The catheter so called 'PUSHPAMETRA' by saviour
surgeon Sushruta, has become an inevitable device and fulcrum for urethral surgery.

The technique of indwelling polythene catheter has its conception in human surgery and it is the result of metamorphosis of the old annoying rubber catheter. In the last few years attempts have been made by a few Veterinary Surgeons to venture the use of indwelling catheter for surgical approach to calculosis. Both urethra and bladder have been used as a venue for catheter.

The development of polymer synthetic materials, possessing unique physical and biological benign characteristics has offered the surgeons, many new possibilities in surgical therapy. Polythene, a polymer, has been extensively used in surgery as bypass, casts, grafts, implants and prosthesis, for replacing, restorative and reconstructive aspects of plastic surgery.

As an important aspect of the problem, the author has felt the necessity to survey the nature of the incidence of bovine urolithiasis in the region of Gujarat State where this condition is more prevalent. Hence it is proposed to undertake this aspect as a part of the present work.

This experimental work was undertaken to observe the advantages of ischial urethrotomy and indwelling polythene catheter and the length of indwelling period without ill effects to the animal. The entire experiment was designed and conducted to suit its adoption under field conditions.
REVIEW
OF
LITERATURE
Look into the past to discover the
good and recognise the errors and
failings to avoid repetition.

**Medicinal Treatment of Urolithiasis:**

The conservative therapeutic treatment of urolithiasis was possible when taken up in the early stage. In such cases immediate threat to life did not exist, (Selune et al., 1965). They claimed 73% recovery in such medically treated cases.

Blood and Henderson (1963) considered medical treatment as secondary to surgical treatment. They did not think that calculi can be dissolved by medical means. They, however, held that increase in size of calculi and development of new ones can be controlled. Puntriano (1954) and Newson (1954) also agreed with this view.

White et al.(1961) outlined the medical treatment of urolithiasis by adopting one of the following courses:-

(a) Solubility of urinary salts can be increased by altering pH of urine.

(b) Reduction of the concentration of urinary crystalloids by delaying their absorption from the bowel or alternatively by increasing volume of urine.

(c) Precipitation of salts may be prevented by
increasing "protective colloids" of urine.

(d) Smooth muscle relaxant may be used to facilitate the passage of the urethral calculi.

Sodium-bi-carbonate to alter urine pH and to dissolve calculi, was used by Wooldridge (1912) and Moussu as cited by Newsom (1938). Newsome claimed excellent results using soda-bi-carb along with sodium hyposulphate. He advised to give soft water and withhold minerals during treatment. LeGrand (1939) found monobasic sodium phosphate efficacious in urolithiasis of cattle, as long as obstruction was not complete. Blood and Henderson (1963) gave similar advice. Sodium citrate was the drug of choice for changing the reaction of urine to dissolve calculi (Pool, 1960). He also gave reference of sodium phylate in human practice. Similar results have been found with ammonium chloride and phosphoric acid (Crookshank et al., 1960).

Ad-lib water, lowered the crystalline concentration of urine. Baldwin (1960) used Acetozolamide diuretic to dilute the urine further in cases of partial urethral obstruction due to calculi. He claimed 69% results. Cornelius et al. (1960) failed in the same treatment.

Acetozolamide also blocked the formation of bicarbonate and maintained blood electrolyte to minimum. Baldwin (1960) claimed 67% recovery. Frank et al. (1961) stated that incidence could not be decreased with this drug.

The hyaluronidase was used for the disintegration
of the urinary calculi and prevention of recurrence, in human practice (Butt, 1952). Such therapeutic measures have, however, not proved successful in bovine practice (Puntiario, 1954). He opined that it could be used as a preventive measure. The preventive effects of hyaluronidase are linked to the properties of the so-called 'hydrophilic' or protective urinary colloids. Harding (1955) used it with success in one case. He suggested its use for prevention.

Millium (1955) suggested the use of testosterone to increase the tone and size of urethra, in cat.

Ferguson (1939), Smiddy (1954) and McCown (1955) repudiated colloidal action of hyaluronidase.

Urinary obstruction due to calculi was common in the male particularly in animals castrated at an early age, due to poorly developed urethra (Marsh et al., 1957). It was reasonable to expect that drugs which relaxed the smooth muscle of urethra would also assist and facilitate the passage of urethral calculi (Garry et al., 1959; Barrington cited by Pool, 1960).

Schein (1951) propagated 'Depropanex' (Merck-Sharp and Dohm) as a muscle relaxant for urethral calculi. It was deproteinated nitrogenous fraction of the mammalian pancreas extract, Ocitin - i.e. methyl-iso-octanlyamine. Dose was 10 c.c. i/m. Prior et al. (1952), Gibban (1956), Tanken (1958), Perlicka (1961), Blood and Henderson (1963) have also advised the use
of Depropanex in suitable cases. Oelune (1965) claimed good results with muscle relaxants. They held that the success could be attributed to the relaxation of the involuntary retractor penis muscle rather than that of urethra which contained very little smooth muscle. They also referred the fibrous tunica albuginea - precluding dilatation of urethra.

Sheel and Paton (1960) advised the use of aminopromazine for successful removal of bovine urethral calculi by manipulation. They showed that it exerted a direct spasmodic action on bladder and by inference on urethra. Baldwin (1960), Blood and Henderson (1963) and Oelune (1965) have also advocated the use of aminopromazine.

Jackson (1961) stated that there was no efficient known treatment for bovine urolithiasis.

The Surgical Approach:

Various workers have expressed their opinion regarding surgical approach for obstructive urolithiasis in bovine.

Newson (1939) expressed that many cases required surgery to save the life. Puntriano (1954) described this as the most rational approach. Perlicka (1961) and Blood and Henderson (1963) considered it to be a primary approach in unresponsive cases. Oelune (1965) accepted surgical intervention as a necessity.

Fleming (1902) described the outline of the present
day ischial and post scrotal urethrotomy in male bovine. He showed that pre-scrotal urethrotomy was preferable with many surgeons as the penis was easily accessible and its withdrawal out of skin incision offered no problem. Fleming advocated ischial urethrotomy in two conditions. First when the rupture of bladder was apprehended and second when calculi could not be located. In his opinion the pre- and post-scrotal urethrotomy was a generally necessary to extract out the calculi.

His technique consisted of incising skin in the midline, dissecting the penis and withdrawing the same out of skin incision. He divided retractor penis muscle. He advised to take as small an incision as possible on urethra. No mention was there to suture urethra. He, however, did find that suturing skin incision was not necessary. He held that would gradually healed spontaneously.

Wooldridge (1912) practised ischial urethrotomy with the same objects that of Fleming (1902). He used catheter through urethrotomy opening to evacuate bladder. Alternatively he used curved trocar camila per rectum for evacuating urine. He held post-scrotal urethrotomy to be less successful.

Wagner (1924) brought a lead flexible sound as an aid in urethrotomy operation. It helped in locating exact place of the calculi.

Cozzens (1932) suggested and practised urethrostomy and urethroplasty in small animals for surgical approach to
calculi. This was to obviate stenosis. In the following years this method seemed to have become popular in large animal practice.

O'conner (1937) referred ischial urethrotomy as safer and palliative and post-scrotal as curative. He suggested suturing urethra to prevent urine infiltration and subsequent complications.

Newson (1938) stated that ischial urethrotomy was necessary to save life of the animal.

Guard (1939) specified the incision. He described to incise skin-fascia, between the two retractor penis muscles and corpus cavernosum urethra. He also emphasised that the length of the incision should be gradually shortened, from the lower commissure of the skin wound, to that of the urethral wound. This, he stated, facilitated drainage. He did not indicate about suturing.

Carey (1940) practised ischial urethrostomy and exteriorization of urethra after amputation of penis, in unfinished steers and salvaged bulls. To anchor penis firmly, he sutured corpus cavernosum on each side with skin. He believed that this would afford a direct and unobstructing drainage of urine. He used to make 1" split incision in urethra, spread it out fan shaped and sutured to the margins of the skin. This prevented any stricture formation. When wound healed, it formed a permanent artificial urinary meatus.
Pillai (1942) performed post-scratal urethrotomy in a bull but no urine could be drained. Additional surgery included successful perineal operation, which resulted into a fistula. Post scrotal wound healed uneventfully. He used catheter to drain urine from perineal wound.

Mathew (1942) reported an unusual case of calculi in the sheath of a bullock. Sheath was rather unusual site for urinary calculi. He removed the calculi of 2" x 1/2" by a scoops through the prepuce opening.

Subbarayudu (1944) reported to have operated five cases of urethral calculi. One which was operated in prescrotal region with skin suturing resulted in permanent fistula, in the bullock. He operated two buffalo bulls in post scrotal region.

Sambamurthi (1947) described a case of urethral calculi with rupture of urethra, urine infiltration and gangrene of sheath. Ischial urethrostomy was performed. He removed the gangrenous part along with the distal portion of the penis. He advocated the ischial approach and held that it facilitated easy drainage of urine and obviated infiltration and subsequent complications. He emphasised that sequelae with various complications presented serious handicap in urethrotomy.

Frank (1947) used lead sound under epidural anaesthesia to locate urethral calculi in breeding bulls. He performed urethrotomy at the actual site of calculi. For advanced cases and in cases of urethral rupture, Frank advised post
scrotal approach. His approach was to amputate the penis in cases of extensively damaged urethra. He preferred to leave the distal portion of penis after amputation and allowed the urethral wound to heal spontaneously. In cases of ruptured bladder, he preferred urethrotomy along with laparotomy for repair of bladder. Frank used to operate in raised position of the posterior part of the animal, while the shoulders, head and neck rested on the ground.

Desmond (1950) described post scrotal urethrotomy in a bull. Later ischial urethrotomy was performed on the same animal, as an additional surgical measure.

Wheat (1957) practised urethrotomy on lines of Cary (1940) and Frank (1947). He did not advise suturing the urethral wound. He expressed that urethrotomy operation was not successful as it resulted in stricture and recurrence.

Sinha (1952) has reported his observations on 100 cases of urethral calculi in male bovines. He maintained that the operation was difficult and the percentage of success was also limited. He practised post scrotal urethrotomy without suturing the urethra or the skin. He particularly referred to two common sequels; oedema and persistent fistula.

Vearya (1958) reported a successful case of urethral calculi, with ruptured bladder. He did not suture urethra after urethrotomy. He stated that after four days, urine started draining through the natural passage only.
Kiesal (1956) introduced a new type of urethral sound for the bull, which served as an important aid in urethrotomy for locating urethral obstruction and stricture. He held that the old lead sound, suggested by Wagner (1924), was a harsh instrument. The new sound was prepared from 114" speedometer cable with 1/8" in diameter. The sound was passed under pudendal block. He pointed out the presence of mucous membrane forming a diverticulum in the dorsal wall of the urethra near the ischial bend. This diverticulum formed an obstruction in the passage of sound.

Gibbons (1955) advised the ischial urethrotomy and exteriorization of urethra as described by Carey (1940). He described urethrotomy as rarely successful.

Beamer (1959) has referred to unsuccessful urethro-colostomy in cat for recurrent urethral calculi. He referred to successful transplantation of neck of the bladder into the colon to alleviate urethral calculosis. Mannari (1966) also referred to such technique in dog, while the same technique is not practicable in large animals.

Smythe (1959) held that surgery in urethral calculi in bull was only confined to the relief of distended bladder. He was of the opinion that even if radical operation was undertaken, condition invariably recurred, therefore there was no need to waste time over it.

Ewald Berge and Melchior Westhus (1961) in their
text book referred the radicle operation under 'Gombelen' infiltration or high epidural anaesthesia. They suggested the use of equine catheter to examine urethral potency. They maintained that urinary fistula generally heal spontaneously. Alternatively they advised suturing the urethral and skin incision. They even referred that some time the haemorrhage from corpus cavernosum remained uncontrollable.

Ferlicka (1961) practised all types of medicinal treatment including electro-ejaculation to dislodge the obstructing calculi. When surgical treatment was resorted to, he claimed much better results. He advised post-scrotal urethrotomy under epidural anaesthesia.

Gelune (1965) practised post scrotal urethrotomy and exteriorization of urethra. He used to perform under epidural anaesthesia in standing position. He used to sever the retractor penis muscle and brought the whole penis out of the skin incision. He used modified parallel mattress suture for fixing the penis to the skin flaps. In simple ischial urethrotomy, he claimed 53% success.

Gelune suggested a very useful modification in the technique for breeding bulls, and other selected cases. He advised a slight rotation of the fascia surrounding the penis at the site of calculi, before taking a very small direct incision over the wall of the urethra. After removal of the calculi the fascia was allowed to rotate back to its normal
position. The intact rotated fascia, in apposition to urethral incision, may help in preventing the leakage of urine during the healing period of incised urethra. This appeared like grafting autogenous fascia, without using any suture. The technique prevented usual complications. He sutured skin incision after using this technique. The author claimed 95% recovery rate.

Metcalf (1965) evolved a new nonsuture technique of closing the urethral wound in post-scrotal urethrotomy by employing Methyl 2-Cyanoacrylate monomer as a rapidly polymerising agent. He advocated that the urethra should be incised from dorsum of penis at the site of calculi.

For the technique, he had emphasised that the adhesive may be applied on dry surface of the wound. All moisture should be removed by dry gauze sponge. Loose connective tissue should be removed. He has also advocated that in order to afford further strength to the closed incision, a collagen fibre patch can be applied over the monomer adhesive.

As special features of this technique, he recommended the use of polyethylene gloves, 7 fr-x-ray urethral whistle tip catheter. 73 operations have been reported by the author with excellent results.

Koppar (1987) has reported 275 operations of urethrotomy in bullocks. The author performed all the operations behind the scrotum on sigmoid flexure. He claimed 43% success. He concluded that complication of stricture can be averted by
incising urethra in between the two curves or below the posterior curve. The author held that displacement of calculi to suitable place was advantageous if possible.

Surgical approach with the use of catheter:

Catheter has been known to the medical world since the time of Sushruta (500 B.C.). He called it "Pushpanetra" and specified the length of 14 fingers' breadth and diameter broad enough to pass a flower stem. Avicenna developed and introduced flexible catheter way back in 10th century A.D. (Attawater, 1943). He also made a mention of catheter in Roman period.

Erasmus in 200 B.C. used 'S' shaped catheter for surgery on stricture of urethra, (Attawater, 1950). He also saw a catheter belonging to 1st century B.C.

Celsus who lived in 1st century, gave a description of 'S' shaped catheter (Mishra, 1980).

Fleming (1902) described equine catheter - Brognier's catheter. It was cylindrical copper canula with longitudinal and spiral rings covered by leather. This catheter had a square steel stilette.

Next metamorphic stage of catheter was moulded from India rubber, which was followed by Gum-elastic catheter. Even today, this flexible catheter answers the purpose. He also described a double channeled catheter for irrigation of bladder.
Fleming considered ruminant catheterisation of the bladder, impossible because of sigmoid flexure.

Wooldridge (1923) referred that long human stomach tubes of rubber were used as catheter for horses. He agreed with the idea of Fleming regarding ruminant catheter. He said that catheterisation was possible immediately after service. He adopted the utility of catheter after ischial urethrotomy. This was for the purpose of draining urine after surgery. He opined that catheter can easily be pushed up to bladder through ischial urethrotomy opening.

O'Conner (1950) introduced catheter after performing ischial urethrotomy to drain urine. He suggested a fine gum-elastic catheter to be necessary to correspond to the narrow lumen of the bovine urethra.

Guard (1951) also advocated the introduction of catheter, without any change from his predecessors.

Metcalf (1965) used 7 Fr. x-ray catheter to introduce in the urethral lumen. He inserted this through ischial urethrotomy opening to prevent entering of playmer adhesive in lumen while closing urethral wound in sutureless technique.

The original rubber indwelling catheter became more prominent in human surgery when Peter Freyer modified McGill's operation of suprapubic prostatectomy. Peter Freyer used indwelling rubber catheter in bladder to prevent urine contamination of prostatic urethral wound (Albert Carless, 1924).
Indwelling catheter was also used in several human surgical interventions like, suprapubic lithotomy and cystotomy, Syme's, Wheeler's and Cock's operations. It was extensively used in bladder paraplegia due to traumatic spinal cord, (Choudhary, 1964).

The experiences of intermittent catheterisation during the first world war brought the conception of indwelling catheter in the forefront (Choudhary, 1964).

Desmond (1950) first attempted successfully the indwelling of a 'T' shaped steel canula in a bull. The tube was inserted in ischial urethrotomy opening. It was kept for three months during which sepsis developed. Attempt was also made to collect semen through the tube.

Arther et al. (1954) performed ischial urethrotomy and successfully indwelled rubber catheter in dog. It was a case of urethral calculi. The urethra was sutured perpendicularly, to the direction in which it was incised, so as to leave larger lumen at the site. The overlying tissues were then drawn over the urethral incision and sutured. This obliterated dead space if any. The skin incision was sutured which healed with first intention.

It was these authors who suggested similar technique in the urethrotomy operation for the removal of urethral calculi in large animals, especially in valuable bovines. They ruled out any post operative sequelae if such technique is adopted.

McCally (1955) described a similar surgical procedure
for urethral calculi in cats. He performed antipubic urethro-
tomy and employed indwelling catheter for a few days. Surgical
technique included laparotomy, exposure of bladder, severing
the urethra anterior to Cowper's gland, closing of the abdomi-
ernal wound; second incision ½" posterior to the first one,
urethra slit and sutured with skin and catheter indwelled. He
claimed excellent results.

Smythe (1959) also used to indwell a stainless steel
'T' tube in ischial urethrotomy opening. The lower limb of the
the 'T' was made solid. The urine emerged at the protruding
portion, which carried the urine behind the level of the body.
He claimed that the bulle would serve in that condition and
that semen can be collected in that method.

Fuechsel and Rollins (1959) used indwelling of
plastic intact stomach or feeding tubes in urethrotomy to
ensure patency. They cited Rollins who reported that as high as
possible ischial urethrotomy was preferred to distribute the
urine away from the body.

Noordy and Throtter (1963) stated that bovine
urethral calculi cases, which did not respond to routine treat-
ment of post-scrotal urethrotomy were subjected to additional
surgery, to by pass the urethra and establish a functional
passage for urine. His technique included laparotomy in left
paralumbar fossa, insertion of trocar from the floor of the
abdomen, puncturing the bladder in fundus ventrally and anchor-
ing there the rubber catheter with synthetic suture and passing
the other end through the trocar and suturing to the skin.

Mahanti et al. (1963) successfully indwelled rubber catheter for seven days without infection, in five calves operated upon for clinical urolithiasis. Their technique included laparocystotomy, removal of calculi, passing catheter No. 7 through the neck of the bladder to perineal region, performed ischial urethrotomy, pushing the catheter in the urethrotomy opening, anchored the catheter in bladder with catgut, suturing the bladder, closing abdominal wound, sutured urethrotomy incision with indwelled catheter.

It was Gibban (1958) who replaced rubber indwelling catheter by new synthetic polythene and polyvinyl, one place indwelling catheter in human surgery. Robert (1965) evolved silastic indwelling catheter.

In feline urethral surgery, Whitehead (1961) first used polythene tube for indwelling catheter. He suggested prepubic urethrostomy employing a permanent indwelling of polythene tube, as surgical treatment for more obstinate feline urolithiasis.

On reviewing the available literature, it was felt that Khan (1963) was the first to use polythene indwelling catheter in bovine urethral surgery. He successfully operated five clinical cases of urolithiasis by indwelling polythene tubes. In three cases he performed ischial urethrotomy and indwelled catheter. In one case of prescrotal obstruction, first ischial operation with indwelling catheter was resorted to.
After four days, the prescrotal urethrotomy was performed. In one case, laparocystotomy was mandatory since urine could not be drained through the catheter in ischial opening. He also reported 53% success in 43 operations in M.V.C. Hospital.

Hastings (1965) suggested rubber retention catheter in bladder in cases with ruptured bladder in bovine urethral calculi. He claimed the method was quick, simple and effective with excellent results. He performed laparotomy and buttoned up rubber catheter with mushroom head in the bladder. He kept the catheter long enough to play between the bladder and the abdominal wall. Hastings accepted the deterioration of rubber catheter and predicted better results with synthetic vinyl or neoprene catheter.

Oelune (1965) also practised indwelling catheter in bladder. The technique was similar to that of Hastings (1965). He claimed 67% recovery rate. He did not prefer plastic tubes as they failed to produce tissue reaction required for healing of the bladder incision.

Catheter and Infection:

The battle cry against indwelling catheter was "introduction of bacteria" a controversial issue (Commer, 1960).

Mill (1950) indwelled steel tube in bull which resulted in introduction of infection.

McCally (1955) after indwelling catheter following urethrotomy observed no ascending infection. He claimed that
natural defence tended to prevent it.

Noores (1963) recorded cystitis only in one out of several cases in which he indwelled bladder catheter.

Khan (1963) and Mahanty (1963) who indwelled urethral catheters did not report any infection.

Hastings (1965) expressed that there is ample scope for infection, with indwelling catheter in bovines; in practice it has not been experienced.

In human practice for years, urologists have been trying to eliminate the use of catheter and found it was embarrassing to come to its defence openly. Ascending infection along the catheter still remained a question (Ansell, 1963). He held that resistance to immediate environment developed, and agreed with Gillespie et al. (1960) who stated that catheter was not a major source of infection.

The use of antibiotics during the period of indwelling catheter, was of debatable value (Clarke and Jareas, 1960). Sextan (1961) stated that antibiotics did not help much.

Beeson (1960) thought infection was inevitable.

Kas and Schneiderman (1957) held that catheterisation followed infection of aerobacterium proteus, pseudomonas or enterococci.

Cox and Hinman (1961) ruled out infection and attributed this to local tissue immunity of the bladder. They termed it as "bladder defence mechanism".

Clark and Joreas (1960) stated that the normal
bladder not only delayed the onset of bacteriuria but was also capable of clearing itself of infection.

Cibban (1968) defended polythene and polyvinyl indwelling catheter stating that urethritis, perineal abscess and epididymitis could be avoided.

Comarr (1966) cited Gutman's observation that catheter did not cause infection. Comarr held that even abnormal bladder, i.e. traumatic bladder with prepared soil for infection was capable of clearing itself of infection.

Pathological reaction of Polythene:

Gelune (1965) indwelled catheter in bovine bladder. He stated that plastic tube did not produce tissue reaction.

Metcalf (1965) who used synthetic agent for closing the urethral wound in bovine, mentioned that an insignificant amount of reaction was noticed. Autian (1966) also supported it.

Noelle (1966) described the histopathological reaction of polythene when embedded in muscles of guineapig. Muscle fibres adjacent to polythene were either necrotic or atrophic in the beginning but in cases of longer duration it was not observed. Fibrous tissue always separated the muscle from the polythene. Around the mass fibroblasts were most common. Large eosinophils were conspicuous. Later lymphocytes were common.

The fibrous capsule, devoid of inflammatory elements, developed around the polythene tubings embedded in the tissues of dog, man and guineapig have been reported by Ingram et al.
(1940); Gauthworth (1949); Kim et al. (1954); Moor (1954); and Anthony (1963).

Polythene prosthesis, whenever implanted were also encapsulated by fibrous tissue devoid of inflammatory elements. They were well tolerated (Judet and Judet, 1950; Newman and Scales, 1957; Debrunner, 1953; Collins, 1954; Scales, 1957 and Rubin and Holden, 1958).

Incidence of Urolithiasis in Bovine

Calculi occurred as a result of the interaction of several factors (Blood and Henderson, 1963).

Urolithiasis was reported to be the most common in cattle and sheep (Woodrige, 1923).

Mangrulkar (1927) reported urinary calculi in rabbit.

Rutyna et al. (1943) stated that the condition was most common in horses and cattle. They cited Wegaly who found urolithiasis in 0.24% of 22104 bovines, and Woodruff who observed 10% in steers.

O’Connor (1950) stated it to be common in all domesticated animals. He stated larger stones in horses and dogs, while smaller ones in cattle.

Miller and West (1953) stated it to be more common in cattle. Davis (1955) stated that urolithiasis in bovine was not uncommon.

Frank (1961) stated it to be frequent in male cattle
but rare in horses.

Blood and Henderson (1963) stated in their textbook that it was common in castrated ruminant. They drew the attention that urolithiasis in cattle (steers) was second in importance to respiratory diseases in U.S.A.

Several factors have been considered affecting incidence by various workers.

Age:

O'Connor (1950) stated that stone was more common in old animals. He reasoned that in advanced age, consumption of minerals, for upkeep of bone, decreased which predisposed to calculosis. Wooldridge (1923) and Davis (1955) also referred to age as one of the factors.

When (1963) gave a survey of 50 incidence recorded in the hospital of Madras Veterinary College during 1958-'60. He recorded 42 incidences under one year of age.

Castration:

Castration was conducive to high incidence. Marsh et al. (1957) proved in their experiment that a bull had greater urethral diameter than a castrate of the same age. They also concluded that a calf castrated at the age of seven months could pass a stone 13% greater in diameter and a bull could pass 44% greater than a calf castrated at the age of one month could pass.
Willium (1955) referred the direct relationship between the effects of castration and decreased urinary colloids which was a great offender of calculi formation. He hypothesised the vicious chain reaction of absence of testosteroneless synthesis of hyaluronic acidless-hydrophilic colloids and more calculus.

Bunce (1952) supported the theory as a predisposing cause of calculus in cats. Weiler (1960) categorically criticised that deemed presumption of castration was based on assumption rather than any scientific proof.

**Feeds and Fodder:**

High nitrogenous concentrates in larger quantities, dry fodder deficient in vit.A, molasses, root crops, excessive wheat bran, cotton seed oil cake, and mineral mixtures have been reported to increase the incidence of urolithiasis (Eveleth, 1934, 1939; Newsam, 1939; Block et al., 1947; Janes et al., 1950, 1951; Davis, 1955; Cornelius, 1959; Blood and Henderson, 1963; Emerick et al., 1964 and Bushman, 1965).

Puntriano (1955) suggested that it would be of great importance if direct relationship between nutritional constituents and protective urinary colloids was established. This would give a better idea regarding their role played in genesis of calculi.

**Geographic Districts:**

Several workers have emphatically stated that the
incidence of urolithiasis remained high in chalky districts. Lime of the soil rendered the water hard and the fodder contained higher minerals (Newsam, 1939; Dallinger, 1934; Hutry et al., 1943; Swingle et al., 1953; Dutta et al., 1959; Frank, 1961 and Blood and Henderson, 1963). Higgins (1951) included India, China, Russia, South California and Mexico in the stone forming belt.

Wooldridge (1923) and O'Connor (1955) maintained that fodder grown on soil treated with artificial manure and top dressed with lime, tended to increase the incidence.

**Heredity:**

Wooldridge (1923) and Oelune (1965) stated that heredity was a predisposing factor. Clude (1940) showed that in Dalmation breed of dog, the incidence of calculi was high. Bunce (1956) agreed with Clude. Krook and Amsden (1956) reported that chondrodystrophic breeds were predisposed towards this condition.

**Season:**

Newsam (1939), Swingle et al. (1953) and Willium (1955) stated that urolithiasis occurred more in winter. Kopper (1967) who observed 275 cases, also reported more cases in winter. Puntriano (1954) referred that incidence of calculi were more in summer in human population of subtropical area. Higgins (1949), Tan Aired (1957) and Blood and Henderson (1963) stated that sunlight in hot climate tended to increase the
incidence by affecting vit.D formation. Previous workers (Wilder and Howel, 1936, and Pyroh and Fawweather) also held the same view.

Sex:

Wooldridge (1923), Hutyra et al. (1943), Frank (1961) and Blood and Henderson (1963) and several other workers held that urolithiasis was most common in male cattle. Many held that short and dilatable urethra did not allow females to suffer from obstruction.

Scott et al. (1943) stated that oestrogen increased the citric acid excretion which lowered the output of calcium in urine. "Citric acid excretion was less and stone more in male". Blood and Henderson (1963) agreed that depression of citrate content favoured the formation of stone.

Stress:

Puntriano (1955) stated to have observed that the formation of protective urinary colloid virtually disappeared, during times of stress. He explained that stress of sever weather inclimeneses would affect adversely the incidence.

Das (1961) referred stress to cause calculosis.

Barney and Minz (1934) and Das (1961) referred texture of skin having a bearing on calculosis.
Vitamins and Hormones:

Huber (1962) stated that vitamin A serves as a prostatic group of an essential protein structure, and also maintained the vital role of preservation of integrity and smoothness of the epithelium. Deficiency of vit. A caused keratinization of epithelium which when cracked became an avenue for encrustation and lithiatic stage. Deficiency of vit. A has been considered as an important predisposing factor in ruminant urolithiasis by many workers (Dallinger and Ross, 1934; Schmidt, 1941; Swingle et al., 1956; Willium, 1957; Blood and Henderson, 1963).

Albright et al. (1934) stated that all stone, containing calcium and phosphorus were the result of hyperparathyroidism. Dallinger (1934) and Newsom (1938) also agreed to this view.

Bovine calculi and its chemical composition:

Fleming (1902) described urinary calculi of very irregular shapes and stated that it depended on its situation. Regarding volume and weight he observed a great variation and described surface as smooth or rough. In connection of chemical composition he stated that chief components were carbonate and triple phosphate of calcium with a little magnesium and variable amount of organic matter. He opined that iron gave reddish tinge to calculi and silicic acid was rarely found.
Low James (1909) classified the bovine urinary calculi into eight types, as per chemical composition. First four types contained calcium, magnesium and ferrous carbonates with organic matter. Fifth type contained magnesium phosphate, calcium oxalate and organic matter. Sixth type indicated silicious calculi with Fe. and Mg. carbonates. Seventh type contained calcium oxalate with calcium and magnesium carbonates and organic matter. The last was gravel.

Michael (1910) mentioned about calcium phosphate in ruminant calculi. Analysis of Larson and Baily (1913) agreed with that of James (1909).

Wooldridge (1923) described ruminant calculi as multiple, having smoother surface and lighter in weight. He described yellowish grey or brown colour of calculi. His chemical analysis remained within the classification of James (1909). He described large calculi in horses.

Ranganathan (1931) doubted to have silica in calculi; otherwise his analysis was in the range of James (1909). Later the same author stated in 1931 that some of the calculi indicated N, P₂O₅ and CaO.

Blunt (1931) listed seven types of calculi in cattle namely - Silicate, Calcium, Oxalate, Xanthine, Calcium and Magnesium carbonate and phosphate, triple phosphate and Ferrous carbonate.

Woodruff (1934) was first to indicate uric acid in calculi of cattle.
Astan (1934) indicated fat, cystin and pigment in bovine calculi, the rest of his analysis tallied with that of James (1909) and Blout (1931).

Joly (1934) stated that lithiasis was more common in old world i.e. countries with old civilisation, than in new world. He stressed that three most important areas of urolithiasis were India, Messopotemia and South China, where civilisation existed from the dawn of history. He reasoned that defective diet, sanitation and hygiene were still a rule in that stone tract.

Butyra et al. (1938) described calcium and magnesium carbonates and phosphates as constituents of calculi. They indicated greyish white, brown and mottled calculi. They also referred metallic and mother pearl luster of calculi due to ferrous carbonate. They described lamination in the structure of calculi.

Newsom (1938) expressed that since the urine of cattle was normally alkaline, phosphatic calculi were more common. He further reiterated that practically all analysts agreed regarding calcium, magnesium and aluminium salts of phosphoric acid as constituents of calculi. He referred uric acid and cystin as organic constituents of calculi.

Cunningham and Cunningham (1938) in their analysis found that calculi contained considerable amount of calcium and traces of magnesium and carbonates. They stated that calculi contained 50% of organic matrix of which protein was less than
They did not find phosphate and sulphate.

Mathews and Sutherland (1951) reported silica and traces of oxalate in calculi.

Sinha (1952) analysed the bovine calculi and gave the following quantitative figures:

- Calcium carb.  71 %
- Mag. carb.  26 %
- Ca₃(PO₄)₂  3 %
- Urates  -
- Oxalates  -

Swingle (1952) reported NH₃, CO₂ and PO₄ in different calculi. He revealed that protein and silica were universal occurrence in bovine calculi. Swingle (1955) reported that bovine urine contained soluble silica and considerable mucin and hence were made up of mucoprotein. Aired (1958) stated that the earliest urinary calculi known was discovered by Prof. Eliot Smith in 1901. He excavated a calculi 2½" long, with an outer coat of phosphate, from the pelvic bones of a young boy, died and cremated in 4800 B.C.

Charles and Bishop (1961) reported extensive work in the histochemistry of the uroliths of domestic animals. They referred the lamelli of the calculi.

Blood and Henderson (1963) reported calculi containing calcium, ammonium and magnesium carbonate as the common constituents, in cattle.
Materials and Methods

Region:

The present pilot survey of incidence of clinical urolithiasis in male bovines, included six districts of Rajkot Region of Gujarat State. The names of the districts are, Bhavnagar, Kutch, Jamnagar, Junagadh, Rajkot and Surendranagar. This area is known as Saurashtra, which is a peninsula surrounded by Arabian Sea as shown in the accompanying map No. 1. The region is in the extreme west of India, between 20° and 22° north latitudes and 69° and 72° longitudes. Desert of Kutch, forest of Gir, large pockets of water logging areas, largest of which is known as Nal-Sarovar, form important physical features of the area. Khar-lands towards the coastal area, are the results of tidal sea water. Rocky and hilly tracks also form the parts of the terrain. The cultivable soil is generally black. Chalky parts are also found. There are number of quarry from where white lime stones are excavated. The rain fall is low to medium ranging from 20 cm. in Kutch to 80 cm. in Junagadh district. During the months of May and June, the high temperature varies between 105°F to 115°F, while during December and January the low temperature varies between 70°F to 80°F.

Livestock:

The area is the home of Gir breed of cattle,
Jafarabad breed of buffalo and Kathiawari goats and sheep. Bullocks of two breeds, Kankrej and Gir, are used; the former is more preferred by the farmers. The cattle population of the six districts as per the census report 1961, is given in table No.1.

Crop:

The main crop of this area is ground nut. The crops of second choice are Millet, Jawar and Cotton. Irrigation facilities are scanty, sub soil water being at deeper level.

Feeds and fodder:

Hay, Sativa annulus, Jawar straw and the dried leaves and stem of ground nut crop, form the major bulk of dry fodder. No treatment of any type is given to the dry fodder before feeding it to livestock. Dry fodder is supplemented with ground nut by-products generally for valuable Bullocks. Lucern, green Jawar, Maiz and carrot form the major items of green fodder whenever and wherever available. Greens are not easily available during the months of March to June and start getting readily available throughout the months of August to November. Cotton seeds and ground nut oil cake form the main items of the concentrate mixture and to a lesser extent wheat bran.

Source of Bullocks:

Majority of the Kankrej calves are sold by the
nomadic breeders, who castrate the calves at a very early age by open method. Generally the farmers purchase these Kankrej calves and rear them for future use, with special attention to their feeding. The Gir bullocks are generally home bred animals.

The survey:

The survey of the incidence of the clinically reported urolithiastic cases in bovine male was carried out in the present work. The area of 35,459 square miles spreaded over the six districts was surveyed, (table No.1; map no.1). The figures relate to the period from April, 1984 to October, 1987.

Data:

The data have been collected from the case registers of Veterinary Dispensaries and First Aid Veterinary Centres (map no.1). The incidences from the collected data, were tabulated district wise, year wise, month wise and age wise. The incidence, in castrated and noncastrated males and that in each breed, were also sorted out. The incidences of unusual nature were recorded.

The relevant data regarding the urethrotomy operations, position and number of calculi and postoperative complications were recorded.

Urinary calculi:

The calculi collected from the region were subjected to physical examination for shape, size, texture, colour and
weight. The qualitative chemical analysis of the urinary calculi was undertaken as per the spot tests of Miner and Notica (1943) for detecting phosphate, oxalate, carbonate and calcium. The procedure of the chemical test is given below:

<table>
<thead>
<tr>
<th>Radical</th>
<th>Procedure</th>
<th>Inference</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Phosphate</td>
<td>Powdered stone + 4 to 5 drops of ammonium molybdate.</td>
<td>Distinct yellow ppt. (May be warmed).</td>
</tr>
<tr>
<td>2. Oxalate</td>
<td>a) Powdered stone + 2 to 3 drops of 10% HCl, if no effervescence, cool and add a pinch of MgO.</td>
<td>Tiny bubbles of gas explosively released from the bottom.</td>
</tr>
<tr>
<td></td>
<td>b) Char small fragments on spatula and add 10% HCl.</td>
<td>Foaming effervescence.</td>
</tr>
<tr>
<td>3. Carbonate</td>
<td>Relatively large sample of powdered stone + 8 to 10 drops of 10% HCl (save for 4)</td>
<td></td>
</tr>
<tr>
<td>4. Calcium</td>
<td>Acid extract (from No.3) + 2 to 3 drops of 20% NaOH.</td>
<td>Fine white ppt. or a film from oxalate stone. Dense ppt. from phosphate stone.</td>
</tr>
</tbody>
</table>

Oxalate was also confirmed by potassium permanganate test. For the detection of magnesium the powder was heated in crucible for five hours. 10% HCl was then added to a pinch of powder. Potassium ferrocyanide was then added to the filtrate. Magnesium was confirmed positive when the solution changed to green colour. It was also confirmed by ammonium hydrogen phosphate test. Meroxide test for uric acid, xanthene and cystine was performed.

Observations and Results

The data were collected from 102 centres of the
region. The total number of clinically reported incidence were 2,322 during the survey period. The monthwise and yearwise figures of the incidence in each district are given in table No.2. The monthwise incidence showing the seasonal occurrence of incidence, have been depicted in graph No.1.

The age-wise incidence of urolithiasis is as follows:

<table>
<thead>
<tr>
<th>Age in years</th>
<th>Incidence</th>
<th>Age in years</th>
<th>Incidence</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>442</td>
<td>9</td>
<td>100</td>
</tr>
<tr>
<td>2</td>
<td>383</td>
<td>10</td>
<td>63</td>
</tr>
<tr>
<td>3</td>
<td>237</td>
<td>11</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>201</td>
<td>12</td>
<td>13</td>
</tr>
<tr>
<td>5</td>
<td>196</td>
<td>13</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>208</td>
<td>14</td>
<td>2</td>
</tr>
<tr>
<td>7</td>
<td>146</td>
<td>15</td>
<td>1</td>
</tr>
<tr>
<td>8</td>
<td>139</td>
<td>16</td>
<td>1</td>
</tr>
</tbody>
</table>

Total: 2052 + 190 = 2242

Incidence reported as adult bullocks: 180
Grand total: 2322

Incidence in one year age group include 138 incidences in age group ranging from 2 months to 10 months. The age incidence seems to be very significant, (Graph No.2).

Out of the total incidence only 259 cases were recorded in Gir breed animals, while the rest 2064 were in
Seasonal incidence of clinically attended cases of bovine urethral calculosis in Rajkot Region of Gujarat State.
Graph showing age-wise incidence
<table>
<thead>
<tr>
<th>District</th>
<th>Area in sq.miles</th>
<th>Human population</th>
<th>Bulls</th>
<th>Bullocks</th>
<th>Young stock</th>
<th>Adult male buffaloes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bhavnagar</td>
<td>3575</td>
<td>11,19435</td>
<td>941</td>
<td>1,51,366</td>
<td>97,842</td>
<td>1155</td>
</tr>
<tr>
<td>Kutch</td>
<td>16567</td>
<td>6,96440</td>
<td>2358</td>
<td>91,936</td>
<td>164,290</td>
<td>1327</td>
</tr>
<tr>
<td>Jamnagar</td>
<td>4020</td>
<td>8,28419</td>
<td>1349</td>
<td>1,48,011</td>
<td>81,380</td>
<td>818</td>
</tr>
<tr>
<td>Junagadh</td>
<td>4100</td>
<td>12,45643</td>
<td>1326</td>
<td>1,98,203</td>
<td>126,090</td>
<td>2493</td>
</tr>
<tr>
<td>Rajkot</td>
<td>4270</td>
<td>12,08519</td>
<td>976</td>
<td>1,74,466</td>
<td>114,504</td>
<td>872</td>
</tr>
<tr>
<td>Surendranagar</td>
<td>2927</td>
<td>6,63206</td>
<td>774</td>
<td>1,03,593</td>
<td>65,569</td>
<td>849</td>
</tr>
<tr>
<td>Total</td>
<td>36459</td>
<td>57,61662</td>
<td>7624</td>
<td>8,67,774</td>
<td>649,675</td>
<td>7513</td>
</tr>
<tr>
<td>District</td>
<td>Ap</td>
<td>Mr</td>
<td>Apr</td>
<td>M</td>
<td>Jn</td>
<td>Jl</td>
</tr>
<tr>
<td>------------------</td>
<td>-----</td>
<td>----</td>
<td>-----</td>
<td>----</td>
<td>----</td>
<td>----</td>
</tr>
<tr>
<td>Bhavnagar</td>
<td>43</td>
<td>44</td>
<td>27</td>
<td>24</td>
<td>26</td>
<td>23</td>
</tr>
<tr>
<td>Kutch</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>1</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Jamnagar</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Junagadh</td>
<td>16</td>
<td>13</td>
<td>12</td>
<td>16</td>
<td>16</td>
<td>17</td>
</tr>
<tr>
<td>Rajkot</td>
<td>7</td>
<td>11</td>
<td>5</td>
<td>13</td>
<td>14</td>
<td>12</td>
</tr>
<tr>
<td>Surendranagar</td>
<td>8</td>
<td>5</td>
<td>7</td>
<td>3</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>72</td>
<td>75</td>
<td>53</td>
<td>58</td>
<td>65</td>
<td>64</td>
</tr>
</tbody>
</table>
Kankrej breed alone.

Incidence in 23 bull calves and 3 bulls were reported, the rest 2296 being in castrated animals. Only three she buffaloes, two cows and one buffalo bull have been reported to have suffered from urolithiasis.

The report of urethrotomy operations and their results were obtained from sixteen centres. Approximately 32% success has been reported from 534 cases operated upon. The range of success from different centres varied from 12% to 50%.

39 cases were reported to have been operated for urethrotomy after rupture of the bladder, out of which only nine recovered.

One to several calculi were observed obstructing the urethral passage. In regards to the location of calculi in the urethra it was found from the reported cases, that in 78% to 97% of cases, they were found in the sigmoid flexure. Out of these, 30% were found at the anterior curve, 28% at the posterior curve and another 23% in between the curves. The rest were found just above or below the sigmoid flexure.

The general complications reported were: urine infiltration, sepsis and stricture resulting in recurrence.

**Calculi:**

**Shape:** Calculi of various shapes have been observed. Majority of the calculi were completely spherical; oval,
bean shaped, flat, irregularly cylindrical, coral shaped, irregular pebble type and several irregular shapes were also found (photo No. 1 & 2).

Texture:

Generally the smooth calculi were more common than the rough ones.

Consistency:

Majority of the calculi were sufficiently hard, while brittle ones were also found. On cutting, the calculi showed concentric layers giving lamellar appearance on the cut surface. The layers were fragile.

Colour:

The light brown was commonly found. Other colours were grayish white, yellowish, and mother of pearl lustre. Shiny metallic variety were of golden yellow and dark colours. One calculi of black colour was also found.

Weight:

The weight of a single calculi varied between 10 mg. to 1002 mg.

Chemical Analysis:

Qualitative chemical analysis of the calculi was undertaken. The results of the analysis are given in table No. 3.
<table>
<thead>
<tr>
<th>Physical characters</th>
<th>Phosphate</th>
<th>Oxalate</th>
<th>Carbonate</th>
<th>Calcium</th>
<th>Magnesium</th>
<th>Uric acid</th>
<th>Xanthine</th>
<th>Silica</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Irregular dark grey.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>2. Shining lustreous metallic.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
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</tr>
<tr>
<td>3. Dull whitish yellow, regular.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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</tr>
<tr>
<td>4. Irregular dark grey.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>5. Shining mother pearl lusture</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td>6. Dark metallic sandy.</td>
<td>+</td>
<td>+</td>
<td>+</td>
<td>+</td>
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</table>
Discussion

The number of incidence during the period of survey indicated the importance of the condition in cattle in this region.

The high incidence in the young animals is quite striking and significant. About one third of the incidence is in the animals under two years of age. Khan (1963) has also surveyed a high incidence in very young animals under one year of age. O'Connor (1958) and Davis (1955) have stated that stone formation was more common in the old animals.

No specific reason under the present knowledge can be attributed to the high incidence in very young animals. This may be due to the high proteinous diet and change brought over by weaning. Further investigation in this aspect is essential.

From the observations of the survey results, it is clear that the castrated animals formed the largest part of the total incidence. This observation is similar to that of Kopper (1967). Millium (1958), Marsh et al. (1957) and Blood and Henderson (1963) have also agreed that the calculi occur more commonly in castrated ruminant. The castration deprives the animals of the normal development of the urethra, which is influenced by testosterone. Moreover according to Millium (1955) absence of testosterone decreased the hydrophilic colloids and tended to cause calculi formation. Marsh et al. (1957) and Kopper
(1967) agreed that early castration which is generally practised in the region surveyed, is a predisposing factor for calculosis. Deferred castration may lower the incidence.

The high incidence is recorded for four years during the months of March to June in all the six districts. This high incidence occurs in the summer season especially in May and June, when the temperature rises considerably. The results of the observation carried out by Kopp (1967) differ in this regard. He recorded more incidence during January and February, on the basis of material collected from only one veterinary dispensary. The high incidence recorded by him remained at the second stage in the present study. Newsam (1938) and Millium (1957) also stated that the high incidence was recorded during winter. They have reasoned that lower water consumption and vitamin A deficiency during the period affected the incidence. The lower water consumption was due to the water being almost to freezing point. Such conditions do not exist in the area under survey. Swingle et al. (1953) have ruled out the possibility of limited water consumption having any relation to the development of urinary calculi in bovines.

Puntriano (1954) has stated that calculi formation was more during summer in human population living in subtropical area. He reasoned that excessive perspiration and dehydration were the underlying factors for the high incidence during the summer season. Dehydration resulted into the crystalline concentration of urine which tended to cause calculosis. Here it may be
noted that excess of vit. D also tended to increase the formation of calculi. Blood and Henderson (1963) have also shown that sunlight, excess of vit. D and dehydration in hot climate, play a role in calculosis. Walker (1967) also made a mention of this aspect in sheep in Australia.

The other factor that can be attributed to the high incidence during summer season is the lack of green fodder, which in turn causes vit. A deficiency.

From the graph no. 1, it is evident that the incidence was regularly low during the months of August to November in all the districts, when more green grazing is available being monsoon season. The rise of incidence is again noticed regularly from December onwards, when grazing becomes gradually poorer. Factor of vit. A deficiency can be considered to play a role in the incidence depending on the season.

The conditions of soil in this terrain may be considered as one of the most important and specific factors for high incidence. The general factors like early castration, lack of greens and climate may remain more or less common in many other parts of the country and hence soil conditions may be an important factor. Wooldridge (1923) and Davis (1955) stated that geographic district of chalky nature was an important factor in calculi formation. Chalky nature of the soil render the water hard. Newsam (1938) has also expressed that hard water more frequently offered the cause to explain the genesis of calculi, than the other factor. Davis (1955), Dutta et al. (1959) and
Blood and Henderson (1963) have agreed to this view.

In the region surveyed, two districts namely Bhavnagar and Junagadh have high incidence in comparison to the other districts. These two districts have large areas of limestones. Moreover they form a larger part of the coastal area of the peninsula.

It has been observed from the survey, that the incidence in one breed is more than the other. The bullocks of Kankrej breed are used more and hence more incidence has been recorded in that breed. The difference in the proportion of the incidence in the two breeds signify that it is more prevalent in Kankrej than in Gir breed. The present conclusion is based purely on assumption. Gir breed has a loose frame and much pliable skin. It is essential that exact measurements of the urethral lumen of both the breeds may be estimated on the lines of the experiment carried out by Marsh and Safford (1957). They prepared latex rubber casts of urethral lumen and gave the results.

The second factor that can be considered for breed-wise difference, is regarding the skin texture, which differ in both the breeds. Gir breed has smooth, soft and thin pliable skin which is brown in colour. Kankrej breed has grey, non-pliable skin. Barney and Minz (1934) and Das (1961) have mentioned that calculus in human has some bearing on skin texture. No such reference is available for bovine.

Wooldridge (1923) and Dulan (1965) have referred
to heredity as a predisposing factor. No such reference has been available regarding Kankrej or Gir breeds.

The recovery rate of 32% in post scrotal urethrotomy operation is derived from the data. Wooldridge (1923) and Wheat (1957) have mentioned less success in post scrotal urethrotomy. Gibbons (1956) and Smythe (1959) have rarely met with success in this operation. Jackson (1961) recorded only 20% success. Gelune (1965) claimed 53% success, while Koppar (1967) achieved 43% success in urethrotomy.

Nine cases of ruptured bladder have been recorded to have recovered after urethrotomy operation. Gelune (1965) has recorded 50% spontaneous healing of ruptured bladder, after urethrotomy operation.

It is observed that 78% to 87% of calculi are obstructed in the sigmoid flexure. The findings of Marsh and Safford (1957) and the observations of Koppar (1967) are also similar.

The chemical analysis revealed the presence of usual elements as mentioned by previous workers, who have been referred to in the review of literature. Magnesium was absent in one group; while Silica, xanthine and cystin were absent in all groups.

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ANATOMY OF BOVINE MALE

URINARY AND MALE REPRODUCTIVE ORGANS
ANATOMY OF BOVINE MALE URETHRA AND PENTIS

The bovine urethra and penis in which the urethral tube is embedded, contains the following important features:

(a) Sigmoid flexure - double curving of the penis behind the scrotum.
(b) Lining of the urethral groove by tough fibrous tunica albuginea.
(c) Elastic tissue practically absent
(d) Narrowness of the lumen
(e) Penis carried well forward underneath abdomen.

Course of Urethra:

The urethra is a membranous tube extending from the neck of the urinary bladder to the external urethral opening at the tip of the penis. The whole length is divided into two parts, the pelvic and the extra pelvic part.

Beginning at the cervix of the urinary bladder, the urethra passes straight backwards on the pelvic floor. It leaves the pelvic cavity at the ischial arch bending downward and forward. The extra pelvic or the penile urethra is embedded in the urethral groove, in the inferior aspect of the corpus cavernosum of penis.

Pelvic Urethra:

The short pelvic urethra is the widest and the most
Dilatable part of the canal. In the adult male animal, it is about 5" long (Sisson and Grossman, 1947). The greatest width of the pelvic urethra is 3/8". Near the neck of the bladder, it is narrow; thereafter it gradually widens and acquires the greatest width in the middle, and then gradually narrows again at the ischial arch.

Pelvic urethra is surrounded and circumscribed by the urethral muscles, called 'compressor muscle', inferiorly and laterally. The muscle is thick and crescent-shaped. Superiorly, it is covered by the thick aponeurosis. This part has no erectile tissue in its wall unlike penile part. Much of the enlargement of the wall of this part is due to the ductus deferens and the ducts of the seminal vesicles passing obliquely through the wall.

The pelvic urethra is dorsally related to the prostate which is closely adherent to urethral wall. The rectum is just above the pelvic urethra. Both are connected with each other by extensive loose connective tissue. Ventrally it is related to the pelvic floor and the obturator internus muscle.

Extra Pelvic Urethra:

The pelvic urethra, reaching the ischial arch, bends downwards and forwards. The bend is more than 90°. Here it lies in between the crura of the penis, and retractor penis muscle on either side and the bulbourethral muscle above it. At the ischial arch the urethra becomes extrapelvic. From here it follows the course along the urethral groove called the urethral canal at
the inferior surface of the corpus cavernosum penis. The tunica albuginea surrounds the tapering urethral groove. The penile urethra is surrounded by the corpus cavernosum urethrae. In this fashion the extrapelvic urethra reaches the free extremity of the gland penis where the urethra terminates by an opening called, the 'external urethral orifice'.

In the first part, beginning near the ischial arch, the penile urethra forms an enlargement called the 'Bulbous urethra'. In this part the urethra is completely surrounded by the corpus cavernosum urethra longitudinally for about four to five inches. The bulbocavernosus muscle covers the bulbous urethra. Beyond this the urethra and the corpus cavernosus urethrae lie in the urethral canal.

The diameter of the penile urethra gradually diminishes. It is narrowest at the termination. The terminal inch of the urethra is called the 'urethral process'. It is rounded with longitudinal ridge and is attached to the floor of the fossa glandis.

The mucous membrane of the urethra is reddish in colour particularly behind the colliculus seminialis.

The opening of the bladder into the urethra is the internal urethral orifice. The colliculus seminialis is the elongated eminence, presenting two slit-like openings in the median line on the dorsal wall of the pelvic urethra. Each slit has an opening for vas deferens. Two membranous folds, one from the each colliculus seminialis extend forward to make urethral
crest. Two divergent mucus folds extend backwards from the colliculus seminalis upto the level of ischial arch. Here a diverticulum of mucus membrane is present dorsally, facing downward.

The pelvic urethra gets the arterial blood from the vascicular and internal pudic arteries. The penile urethra receives the pure blood from the doesal arteries of the penis.

**Penis**

The bovine penis is longer and narrower. It is cylindrical and a meter long. Though principally made up of erectile tissue, it is remarkably dense and firm. Penile mass starts at the ischial arch. Thence, it passes downwards and forwards between the two thighs; before passing between the scrotal sacs it forms the sigmoid flexure involving about a foot of its body, (fig.no.1). Upto scrotum the penile mass is fixed. Anterior to scrotum the part of the penis is free, rather movable and ensheathed in the prepuce. It is carried well forward beneath the abdomen.

The penis can be described to have comprised of a root, body and glane.

The root is formed by the two crura, with initial part of urethra in between and inferior to the faces of ischia. The crura are made up of erectile tissue. Two erector penis muscles, ischio and bulbo-cavernosus cover the crura.
The cylindrical body of the penis is flattened laterally in its upper part. The sigmoid flexure is formed from the part of the body. The body is suspended from the symphysis ischia by suspensory ligaments of the penis. The dorsal arteries nerves and venous plexus traverse the rounded dorsum penis. The inferior surface has urethral canal which lodges the urethra.

The narrow anterior conical end is the glans penis. It has a thin covering of erectile tissue. Its free twisted extremity has the narrow external urethral orifice.

**Structure of the Penis:**

The penis is covered by a capsule which is formed of dense, white, fibrous, almost inelastic tissue. The substance of the penis is composed of two erectile bodies. One, the corpus cavernosum penis forms the major bulk, the other is the corpus cavernosum urethrae. The former presents inferiorty the urethral canal which lodges urethra and its cavernosum. The corpus cavernosum urethrae surrounds the urethra like a tube. The layer is thick at the root of the penis, forming bulbous urethrae.

**Muscles of the Penis:**

1. **Bulbocavernosus Muscles:** It is an erector penis. It extends from the pelvic outlet below the anus to a distance of about eight inches on the posterior surface of the penis. (Sisson and Grossman, 1947). It is one inch in thickness.
ischial arch, this muscle surrounds the urethra (fig. no. 1), and its erectile tissue. Below it is attached to the tunica albuginea.

(11) Ischiocavernosus Muscle:— It is also an erector penis. It originates from the medial aspect of ischii and sacrosciatic ligament. It is inserted on the crura and the adjacent part of the penis. Artery of the bulb supplies pure blood.

Retractor Penis Muscle:

It is made up of two bands of unstriped muscle, originating from the transverse process of the first coccygeal vertebra. It is inserted at and anterior to the ventral bend of the sigmoid flexure (fig. no. 1). At the root of the penis, the muscle is in a groove in between the two erector penis muscles; thereafter it is ventral to the penis.

This strong muscle is assigned the function of retracting the penis after erection and protrusion and to maintain the sigmoid flexure in the quiescent stage. The perineal artery supplies blood and the pudic nerve innervates it by sympathetic fibres.

Blood supply of the Penis:

The arterial blood is supplied to the penis and urethra by three main arterial branches of the internal pudic artery.

The artery of the bulb supplies the corpus
cavernosus urethra.

The artery, profundus penis enters the organ at the junction of crura.

The paired dorsal arteries of the penis remain on the dorsal surface of the organ alongside the satellite dorsal veins and dorsal nerves.

Nerve supply:

The largest branch of the pudic nerve - the dorsal nerve of penis - innervates the organ.

Histology:

The histology of the pelvic and penile urethra differs as far as urethral glands and stratified urethral muscles are concerned.

Pelvic Urethra:

The pelvic urethra of the bull is composed of, from within out, mucosa, stratum vasculare or cavernosum, trabeculae, urethral gland or prostatic tissue - a sheet of thin bundles of smooth muscle and outermost cover of stratified urethral muscle, (Trautmann, 1957).

The mucus membrane of the prostatic urethra is red in colour and longitudinally folded. The mucus membrane is irregular and marked by recesses i.e. lacunae of Morgagni. The pelvic urethra is lined by transitional epithelium. The
epithelium rests on a thin basement membrane. The thin propria is collagenous and poorly vascularised.

Next, outer to the mucosa is the cavernosum. It is composed of dense plexus of connected veins having the character of erectile tissue. The trabaculae between veins contain smooth musculature.

The glandular tissue contain prostatic tissue or urethral gland. The prostatic gland in ruminant forms a glandular layer in the wall of the entire pelvic urethra (Trautmann, 1967).

Over the urethral gland, there is a sheet of thin bundles of smooth muscle followed by the stratified urethral muscles.

**Penile Urethra:**

The epithelium of the folded mucus membrane of the penile urethra is transitional (photo no.3). It gradually changes to stratified squamous epithelium as external urethral opening is reached. The mucosa of the penile urethra is surrounded by the corpus cavernosum urethrae (photo no.4). It is composed of connective tissue trabaculae. These are the ramifications of limiting tunica albuginea. These trabaculae contain many elastic fibres, blood vessels and longitudinal smooth muscle fibres. The trabaculae and interspaces, called cavernae, make the corpus cavernosum urethrae. The interspaces increase in size towards tunica albuginea. The interspaces are lined
with endothelium and are usually filled with blood as per Trautmann, 1957.
MATERIALS
AND
METHODS
OPERATIVE SURGERY

Selection of Animals:

Buffalo male calves representing the bovine species, which could be readily available were selected for the present study. The animals were purchased at intervals, as and when required. After getting the animals, a preliminary examination was carried out, to ensure that the animals were reasonably healthy so that the results of the experiment might not be vitiated. All the buffalo calves used were found apparently healthy. The average age of the animals varied between 10 months to one year. The weight of the calves ranged between 75 kg. to 90 kg. (table no.1).

The transparent and translucent polythene tubes with diameters ranging from 2.5 mm. to 6.0 mm. were purchased from different companies. The thickness of the wall of the tubes varied from 0.7 mm. to 0.9 mm.

Initially, the perimeters of the urethral lumen in slaughter house specimens were measured. The perimeter of the urethra in one year calves at ischial arch and distal to the ischial arch varied between 6.7 mm. to 11.0 mm. and 10.5 mm. to 11.2 mm. respectively.

Efforts to insert the polythene tubes of different calibres were first made in cadavers. From the measurements ascertained and from the practice on cadavers, it was estimated
that 9 cm. to 13 cm. long translucent polythene tube with diameter of 4.2 mm. was suitable as urethral catheter for insertion and which filled snugly into the lumen of the one year old buffalo calves.

**Design of the experiment:**

In the present plan, eighteen male buffalo calves were operated for ischial urethroty and polythene catheter was indwelled. The general performance, retention period and the effect of the polythene catheter were observed.

**Preoperative preparations:**

**Clinical examination:** The following clinical examination were carried out, before finally proceeding with the operation.

1. Temperature, pulse and respiration were recorded at rest during the preoperative period. The average recordings are shown in table no.4.

2. The fecal samples from the experimental animals were examined for any parasitic or protozoan infection. Positive cases were suitably treated a week before taking up the operation.

**Haematological examination:**

It was carried out by standard methods and no abnormal values were recorded (table no.5).
Urine examination and estimation:

The total quantity of urine passed during the 24 hrs prior to operation was collected individually and measured, (table no.6).

Preparation on the previous day of operation:

The animal was washed and cleaned the previous day, as usual. The ischial region and the upper half of the tail was shaved and cleaned with soap and water. The animal was then separated in a clean, dry stall and was kept on light food and adlib water.

Preparation on the day of operation:

Preparation of the animal: The operation was performed in the morning to avail maximum time for observation during the rest of the day.

The temperature, pulse, and respiration of the animal to be operated were recorded.

The site for the ischial urethrotomy was scrubbed with soap and water and finally with concentrated savlon (I.C.I.).

Sterilisation: All the instruments, drapes, towels, gauze, cotton, Nylon and Silk suturing materials were autoclaved.

The polythene tube was sterilised in boiling water for 30 minutes. The B.P. blades were sterilised in
concentrated savlon (R.O.I.).

Anæsthesia:

(a) Six animals No. 1, 2, 5, 9, 10 and 17 were given epidural anaesthesia. The area of the first inter-coccygeal space was clipped and cleaned in the routine method and 10 - 12 cc. of 1 % procain hydrochloride solution was injected through preparing an insensitive weal, at the sterilised site. It took 10 to 15 minutes for the anaesthetic effect to set in.

(b) Local infiltration - the remaining twelve animals were operated under local infiltration anaesthesia. Procain hydrochloride 2 1/2 % in volume of 8 - 10 cc. was infiltrated in linear fashion on the site below the ischial arch.

Position:

The animal was cast in the right recumbancy and secured by tying the hind legs and left foreleg together with a rope held by an assistant. Maximum exposure of the site was then achieved.

Operation:

The site of operation was finally painted with ept. mercuriochrome 1 %. The site was draped leaving the operative site exposed. The drapes were attached to the skin by Backhaus towel clamps. The left quarter including the anterior part was also covered by a clean towel.
Site of operation and incision:

The bony ischial arch was felt. Two to three inches long incision was made in the median line approximately one inch below the ischial arch. The exposed superficial and deep perineal fascia was cut through by blunt dissection with the help of the scissors. Care was taken to keep this slit narrower than the skin incision. The skin and the fascia were reflected with four Allis forceps which were held by surgeon assistant (photo no.5). This exposed the bulbocavernosus muscle above and retractor penis muscle below. All bleeding points were checked by mosquito forceps or ligature.

Withdrawal of penis out of skin incision:

The retractor penis muscle and the penis were separated from adjoining tissues by blunt dissection. Care was taken to prevent injury to the venous plexus on the lateral wall of the penis. The index finger of the left hand was hooked down and the dorsum of the penis was separated from the underlying tissues. A great care was taken to prevent any injury to the dorsal vessels and nerves of the penis. A tenaculum was inserted beneath the penis to expose it, along with the retractor penis muscle, out of the skin incision. The two parts of retractor muscle were separated away to expose the penis in between them, (photo no.6). Each part of the muscle was drawn apart by applying a thread loop. The fascia at the site of incision was dissected out (photo no.7). The pale white bulging urethra was
felt and confirmed as a hollow tube in the urethral canal.

**Incision on urethra:**

A small incision was made above downward from the lower part of the bulbocavernosus muscle. Bleeding was checked by mopping. Usually urine gushed out of the incision. Care was taken to prevent wound contamination by urine. The two urethral wound lips were then drawn a part by a mosquito forceps.

**Indwelling of polythene catheter:**

The bevelled polythene catheter was then inserted in between the two jaws of the forceps. Whenever the diverticulum at the ischial arch obstructed the passage of the catheter, the same was slightly drawn back, rotated and inserted further. Generally urine immediately drained through the indwelled catheter.

**Anchoring:**

To anchor the indwelled catheter with the urethral wall, a sufficient bite on one side of the wall of urethra was taken with straight flexible needle. Then the needle was passed transversely through the upper third of the tube and the opposite lip of the urethral incision (photo no.9). The two ends of the thread (silk no.1) were tied in such a way that the catheter remained snugly fitted in between the two lips (photo no.9).

The thread loops drawing retractor penis muscle, were
cut and removed. The tenaculum was then drawn away. The penis and the retractor muscle were allowed to return to their position. Five to ten drops of terramycin liquid (Pfizer) were instilled in the wound.

**Wound closing:**

Before closing the wound, it was mopped, dried and cleaned. Placing the stump of the indwelled catheter in the lower commissure, the skin wound was closed in the Halsted fashion using nylon no.1 suture (photo no.10).

The towel clips and the drapes were removed. The area surrounding the wound was cleaned with savlon (ICI) lotion. The animal was released and allowed to stand up.

**Post-operative care and management:**

The recovery after operation was normal in most of the animals. The animals operated under local infiltration anaesthesia, got up immediately and were able to stand and walk, and those operated under epidural anaesthesia, remained recumbent for two to three hours.

The temperature, pulse and respirations were recorded morning and evening till eighth day of the operation (table 4).

The urine was collected from each animal after operation for 48 hrs. and the quantity was measured. The urine samples from each animal were also examined at intervals.
Local treatment:

The wound was cleaned and dressed with apt. mercurochrome 1% daily till the removal of suture. The base of the catheter was daily cleaned and swabbed with apt. mercurochrome 1%.

No parenteral antibiotics were administered.

Removal of sutures:

The sutures were removed on the eighth day of operation.

Management and feeding:

The animals, after the operation, were maintained on hay and greens. Every animal was allowed to graze from the third day of operation.

A close and careful watch on all the animals was maintained.

SURGICAL PATHOLOGY

The animals were euthanised at the end of observation period by intravenous saturated magnesium sulphate. The post-mortem examination was conducted with special reference to the lesions of urinary system. The kidneys, ureters, urinary bladder and penis were collected and preserved in formosaline 10%.

Gross pathological lesions were all noted and important ones photographed.

For histopathological study, paraffin blocks were prepared from the preserved penis and urethra of buff calf.
nos. 2, 3, 4, 7, 10, 17 and 18 by standard technique. The prepared slides were stained by standard H.E. method. Further, the slides were examined for histopathological changes.
OBSERVATION
AND
RESULTS
"FACTS MUST BE CORRECT
THEORY MAY OR MAY NOT BE"

Selve.

Post operative observations of all the animals were divided into three groups.

Group-I
Buffalo calves no. 1, 2, 3, 4, 10 and 17 were observed till the indwelled catheter dropped down by itself.

Group-II
Buffalo calves no. 5, 6, 7, 13, 16 and 18 were observed up to one week after the closure of urethrotomy opening.

Group-III
Buffalo calves no. 8, 9, 11, 14 and 15 were observed up to two weeks after the closure of the urethrotomy opening.

In buff calf no. 12 the urethrotomy opening did not close at all, hence it was euthanised three weeks after the catheter got out and dropped.

GROUP - I

Buff calf no. 1:

The animal urinated after six hours of operation. Urination was followed by sucking sounds for the first four days. The catheter did not cause any inconvenience to the animal.
Urine drained freely through it. The quantity of urine increased gradually through the natural passage (table 6; p.66). By the end of the second week the site of operation appeared slightly bulged as a result of skin thickening and induration. On palpation skin was found adherent to the underlying tissues. Gradually this bulging decreased. The catheter dropped with suture material on the 18th day of the operation.

On autopsy, the penis was found adherent to skin by fibrous tissues. The mucosa of pelvic urethra at the junction of bladder, was congested.

Buff calf no.2:

The animal urinated after six hours of operation and the catheter functioned well (photo no.11).

The catheter dropped on 28th day of operation. The skin was adherent to the penis by fibrous tissues. A fibrous stalk around the catheter had developed which connected the penis to the skin (photo no.12). The mucosa regenerated around the catheter forming annular ridge. The bladder was congested near the opening of the left ureter (photo no.13). Several black pigment like dots were present on the mucosal surface of pelvic urethra. A little mucosal erosion was found at ischial curvature.

On microscopic examination the pelvic urethra showed proliferation of epithelium and leucocytic infiltration (photo no.14). The penile urethra also showed proliferation of epithelium and increased fibroblastic cellularity in lamina propria.
Buff calf no. 3:

The first urination was noticed after six hours of operation. The indwelled catheter drained comparatively less urine. Sucking sound coinciding with the urethral pulsation was also noticed. The catheter dropped on the 18th day of operation.

Gross lesions were similar to that of buff calf no. 2 (photo nos. 15 & 16). No erosion of mucosa was present.

Microscopic examination revealed heavier infiltration around the healing zone and increased cellularity of fibroblast, at the junction of mucosa and corpus cavernosum. A metamorphosis of transitional into stratified epithelium was marked (photo 17).

Buff calf no. 4:

The development of bulging on the scar did not affect the position of catheter which functioned well. The catheter retained up to 19th day of operation.

The gross lesions were same as that of buff calf no. 2. The urethral wound healed well (photo no. 18). Stratified epithelial cell proliferation around the healed up region were noticed. Sections above the healing zone showed proliferation on one side and increased cellularity of fibroblasts in lamina propria (photo no. 18). The urethral wound was found to have healed by fibrous tissue.
Buff calf no. 10:

The animal urinated eight hours after operation. The

catheter retained for 46 days causing no physical changes in

the cicatrix.

The external and internal gross lesions were similar
to that of animal no. 2 (photo no. 20). No erosion or conjuction

was found.

Microscopic examination revealed quite clear epithelial
cells of mucosa (photo no. 21). Wound healed by granulation tissue.

Buff calf no. 17:

The animal urinated after seven hours of operation.
The catheter drained the urine well for two weeks, thereafter
the passage of urine through the natural passage increased. The
catheter remained in position for 19 days.

On autopsy, the gross lesions were found same as that
of buff calf no. 2. No erosion was found.

Histo pathological examination revealed the epithelial
regeneration on the wall of fistula. Sections above the level
of fistula showed proliferated stratified epithelium with a
little leucocytic infiltration (photo no. 22). Increased cellu-
larlity of fibroblast, near the junction of mucous membrane and
cavernous spaces, was noticed.

 Buff calf no. 5:

GROUP II

The animal urinated after six hours of operation.
Stranguria was observed on the first day. The urine drained well through the catheter (photo no. 23). Indurated thickening along the line of scar was observed by second week which gradually subsided. The volume of urine passing through the natural passage increased in the third week. The catheter retained for 18 days. Thereafter, urine drained through the fistula (photo no. 24) and natural passage. The fistula gradually closed by ninth day. Excoriation of the skin in the groin region was observed during closing period of fistula.

The gross lesions showed the development of fibrous stalk similar to that found in calf no. 2. The urethral wound healed well sealing the fistular opening.

**Buff calf no. 6:**

The catheter retained in this animal for 21 days. The drainage of urine increased gradually through natural passage in the second week. The urinary fistula was well organised (photo no. 25) which healed in 9 days.

The skin was found adherent to the wall of penis by a fibrous stalk. Mucosa covered freshly healed portion.

**Buff calf no. 7:**

The animal urinated after five hours of operation. In the second week, bulging at the skin scar was observed which subsided in the 4th week. The catheter dropped after 18 days of operation. The fistula closed in 9 days.
On autopsy the gross lesions were found same as that of buff calf no. 6.

Microscopic examination revealed normal healing of urethra (photo no. 26). Sections above the level of incision showed normal epithelium.

Buff calf no. 13:

The catheter which functioned well dropped after 16 days of operation. The gross lesions were comparable to that of buff calf no. 7.

Buff calf no. 16:

The catheter drained major volume of urine for three weeks and retained well up to 28 days (photo no. 27). The urinary fistula closed in 14 days.

The gross lesions were same as that of buff calf no. 7 (photo no. 28).

Buff calf no. 18:

The catheter dropped after 18 days of operation. The urinary fistula closed in 11 days.

On autopsy the gross lesions were similar to that of buff calf no. 7. A small area of erosion of mucosa was present in pelvic urethra (photo no. 29).

The longitudinal sections through the urethral scar showed healing by fibrous tissue development. Sections above the
scar revealed proliferated epithelium with leucocytic infiltration and increased fibroblastic cellularity in the lamina propria (photo no.30).

**GROUP - III**

**Buff calf no.8:**

The animal urinated six hours after operation. Crouching of back was evinced for two days. The quantity of urine through natural passage increased by the end of third week. Catheter retained for 27 days (photo no.27). The urinary fistula closed in 8 days. The scar at the obliterated fistula was imperceptible (photo no.31).

On postmortem examination the fibrous stalk was found between the healed up part of penis and the external opening of fistula. On removal of the fibrous stalk, a circular scar was evident (photo no.32). On the mucosal surface, a depression in healed up region was found (photo no.33). In pelvic urethra a small area denuded of mucous membrane was found.

**Buff calf no.9:**

The animal urinated after seven hours of operation. In this animal the indwelled catheter remained for 17 days. The fistular opening resulting from catheter, closed in 12 days.

On autopsy the gross lesions were comparable to that of buff calf no.8 (photo nos. 34 & 35).
Buff calf no. 11:

Relatively less quantity of urine drained through the catheter which dropped after 16 days of operation. The skin scar was thickened and indurated.

On autopsy the gross lesions were found similar to that of buff calf no. 8 (photo no. 36).

Buff calf no. 14:

In this animal, sucking sound and rhythmic movement of indwelled catheter during urination was observed for 2 days. Thickening and induration of skin scar had developed which gradually subsided. The catheter dropped after 19 days. The fistula resulting from the catheter was closed in 12 days.

On postmortem examination, the gross lesions were found same as that of buff calf no. 8.

Buff calf no. 15:

The animal was found straining for micturition even after 12 hours of operation. On slight pulling the catheter, the urine gushed out. On the same night, the sutures were opened under local anaesthesia and the catheter was pulled out about 1 cm and reanchored.

The wound gaped on the 8th day of operation (photo no. 37). It was treated by pot. permanganate lotion irrigation and sulphanilamide powder. The catheter dropped after 14 days.
(photo no. 38) and the fistula closed after 16 days.

On autopsy the skin was found adherent to the penis by fibrous tissue stalk. The urethral wound healed normally.

**Buff calf no. 12:**

The animal urinated after 6 hours of operation. The indwelled catheter drained the major quantity of the urine. From the seventh post operative day the urine did not drain through the natural passage, and the animal took more time to void urine through the catheter. The catheter dropped down after 22 days of operation. The urinary fistula, which was well organised (photo no. 39) did not close. The fistula did not cause any inconvenience or excoriation on the skin.

On autopsy it was revealed that the fibrous stalk, encapsulating the indwelled catheter had resulted into an organised tubular passage for the urine. A complete blockage of the urethral lumen below the site of the incision was present (photo no. 40). A constriction was marked on the outer wall of the penis over the stricture.

**General observations:**

The wound healed uneventfully in all the buff calves except in no. 15.

Catheter was well anchored and retained in all the buff calves (photo no. 41) except initial difficulty and additional surgical measure in buff calf no. 15. The indwelled catheter
remained well, sloping vertically downward, and drained the urine in the same direction to that of natural stream, from meatus. This avoided excoriation of skin. The catheter did not cause inconvenience in any animal except buff calf no.15 which kept its tail slightly raised even after the healing of wound and fistula. The position of catheter did not disturb the natural position and movement of the tail. The animals did not appear conscious of the presence of the catheter as a foreign body.

In sitting position the catheter did not touch the ground surface. Dung of normal consistency did not contaminate the catheter; while loose dung soiled the catheter. Except buff calf no.14, no animal made any effort to manipulate the catheter out, nor tried to lick by itself or by other animal.

The skin scar at the end of observation period was imperceptible (photo no.42).

Examination of urine samples showed increase in sp.gr. and traces of albumin in certain cases, during observation period. A few epithelial cells and casts were also found. The reaction of urine was found to be alkaline in all the animals, (table 7).

Comparative blood picture showed slight rise in leucocyte count in the second postoperative week (table 5; p.64).

The dropped catheters were found with anchor stitches. Colour was slightly faint and encrustation, kinking, softening or disintegration was not found.

Other postmortem findings:— The retractor penis muscle remained separate on either side of the fibrous stalk. The kidney
ureter and bladder were generally found normal in all the animals.

A persistent urachus was found in buff calf no. 17. It was like a cord of fibrous tissue about 1.5 cm. in diameter. 5 cm. patent part of it was found communicating with the bladder.
<table>
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Alb = Albumin; Cells = Epithelial & pus cells;
DISCUSSION
Wooldridge (1923) opined that the percentage of success in urethrotomy in bovine was small. Sambamurthi (1947) expressed that postoperative sequelae in urethrotomy presented serious handicaps. White (1937) and Sinha (1952) maintained urethrotomy as a difficult operation. Smythe (1959) experienced that success was rather rare. Berge and Westhus (1961) however experienced that some time haemorrhage from corpus cavernosum during the operation was uncontrollable. Jackson (1962) reported only 20% success and Khan (1963) described the prognosis of urethrotomy as grave with variable result.

Oelune (1965) opined that in radical operation of urethrotomy the mortality was high. Koppar (1967) achieved 43% success in 234 urethrotomy operations.

Thus the urethrotomy operation has been all along looked upon as a difficult one. It appears that this idea is based on unsatisfactory results. The complications and sequelae, following urethrotomy make the prognosis unfavourable. The important complications experienced in the field by all, are urine infiltration through unsutured urethral incision technique, wound contamination by urine, sepsis and gangrene. Irritation from urine passing through the wound, delays or retards healing. Therefore, it is evident that the usual technique employed in radical operation failed to bring satisfactory results.
In the present experiment, ischial urethrotomy operation with indwelling polythene catheter was performed on 18 buff calves.

Fleming (1902), Woolridge (1923), O'Connor (1937), Newsom (1938), Carry (1940), Pillai (1942), Sambamurthi (1947), Desmond (1950), Wheat (1952) and Fuecheal and Rollins (1959) have all preferred ischial urethrotomy since it afforded an immediate and easy drainage of urine from the distended bladder. Further, it helped urine to escape with much greater ease through ischial opening. Through this opening, calculi obstructed at lower level can be located by passing a sound and urethra and the bladder can be flushed.

In the present study the ischial urethrotomy proved successful and advantageous in indwelling catheter. In the ischial urethrotomy opening, the indwelled catheter remained vertically downward. This maintained the position of the stream of urine in the natural direction, prevented excoriation of skin, and made the operation rational and readily acceptable. Further, the skin being more rigid in ischial region the movement of catheter was restricted. Even in sitting position, the catheter did not touch the ground and therefore, the chances of soiling the catheter, or getting foreign material inside the catheter lumen, or contamination, were lessened.

The indwelling of polythene catheter was successful in all the buff calves. Occasionally the diverticulum of mucous membrane in the upper part of the urethra near ischial bend,
presented difficulty in inserting catheter. This was also experienced by Kiesal (1956) while inserting the urethral sound in the bull. This difficulty was also experienced in the operation performed under epidural anaesthesia, because of the atonicity of the tissues.

First urination after operation was generally delayed in all the buff calves, and more so in animals operated under epidural anaesthesia. Celune (1965) has also reported similar difficulty in urination after urethrostomy in bulls. This may be due to following reasons:

(a) Post anaesthetic effect.
(b) Reduction of sensation in bladder
(c) Increased tone of bladder sphincter
(d) Pain due to wound and presence of catheter.
(e) Fluid loss by various routes other than kidney
(f) Less fluid intake due to postoperative stress.

In human surgery also the inability of the surgical patients to void urine during early postoperative period is a common feature (Ilgenfritz, 1948).

The post anaesthetic recumbency in epidural anaesthesia and the frequent efforts on the part of buff calves to stand up prove disadvantageous. In-co-ordinated efforts commonly disturb the freshly anchored catheter.

The delay in urination in buff calf no. 15, may perhaps be due to the tip of catheter entering the urethral or chest. On slight pulling the catheter urine drained promptly thus confirming the above statement. Additional surgery was therefore
mandatory in this case.

The drainage of urine through the catheter was successful in all the animals. Throughout the postoperative period, major bulk of urine drained through the catheter. This prevented the complication of urine infiltration in the surrounding tissues, urine contamination and irritation of the traumatized tissues. Thus the indwelled polythene catheter acted as a urinary prosthesis to bypass urethra. The physiological need of the urethra which had undergone surgery, was also met.

Suturing technique of urethral wound, seal the lumen and prevent urine infiltration and subsequent complications. At the same time suturing of the urethra invariably results into stricture and stenosis. Because of this Fleming (1902), Guard (1939), Frank (1947), Sinha (1952), Verry (1956), Berg and Westhus (1961) and Koppar (1967) have all preferred to leave urethra unsutured, and allow wound to heal spontaneously.

In the present experiment with indwelling of polythene catheter, sealing the urethral wound, was possible. This was accomplished by suturing the urethral wound lips partly over to the polythene catheter wall by anchor suture. Out of 18 buff calves, stenosis developed in one buff calf only. No symptoms of post operative stenosis were noticed till the period of observation. Thus the possibility of stenosis in the present study can be ruled out.

In the radical operation, skin incision was never sutured to facilitate drainage of urine. This usually resulted
in wound infection and sepsis.

In the present experiment indwelling polythene catheter provided ideal condition for closing skin incision. This helped to obliterate the dead space in the wound, decreased possibility of infection and afforded condition for early wound healing by first intention. Wound healing in this experiment, even without using antibiotic, was quite good. With the exception of buff calf no.15, the wound healed very satisfactorily in all the animals. In the present modified technique, this proved to be the most important advantage.

The results obtained by indwelling catheter in the present study were found to be same as recorded by previous workers. With limited material, Khan (1963) by indwelling polythene catheter after ischial urethrotomy got successful results in five calves. Mahanti et al. (1963) also got good results by indwelling rubber catheter after laparocystotomy in five clinical cases. The latter method, under field condition, has very limited application.

'T' shaped steel canula indwelled by Desmond (1950) in a bull, retained for three months; sepsis however developed later and canula dropped out. Smythe (1950) also advised stainless steel 'T' tube for indwelling into urethrotomy opening. The flow of urine from such tube would remain vertical to the perineum. The arm of the 'T' canula hinder the movement of tail in its natural position. There is also certain amount of movement of canula in the lumen. Further larger incision in urethra is
necessary to insert both the arms of "T".

The absence of local, ascending or cross infection, in all except one animal, in the present experiment, agrees with the findings of McCally (1955), Noordsy (1963), and Hastings (1965). No parenteral antibiotics were used in any experimental animal. This confirms with the view of McCally (1955) that the natural defence tended to prevent infection or that resistance to immediate environment developed (Ansell, 1963). Clarke and Jarese (1960) and Sexton (1961) concluded that antibiotics hardly helped since even without antibiotics, the infection remained at the same low level.

Noelle (1965) described that the fibrous tissue developed around the polythene tubings in animals and man. He maintained that the fibroblasts were most common around the polythene mass in the initial stage and lymphocytes at later stage. In the present study, a fibrous stalk encapsulated the polythene catheter between the urethrotomy opening and skin. This is also the observation of Judet (1950) and Man and Scales (1957). In sections of urethra where catheter was in constant touch with the mucous membrane, proliferation of epithelium, was found except in sections of one urethra in which marked unilateral suppression was found. No significant pathological changes have been observed in the parts beyond mucous membrane, as catheter was not in direct connection with it. Increased cellularity of fibroblasts have been found at the junction of mucous membrane and corpus cavernosum, Bharadwaj andCalhaun
(1959) while referring about histology of urethral mucosa have shown the presence of fibroblasts in the lamina propria of mucosa of the urethra of bull. Proliferation of epithelium may be due to the irritation of catheter as a foreign body. It may not be considered as a specific reaction of polythene catheter.

It can be ascertained that polythene catheter was nonreactive, nonadhesive, nontoxic and biologically inert, in urethra. These findings are in accordance with the view of Autian (1966).

Brushing action and lesions of erosion of mucosa were very insignificant in the present study. Such lesions have not been manifested clinically. No encrustation over such lesions have been found. This perhaps rules out the possibility of calculus formation over such lesions.

The examination of urine samples did not reveal any significant change or pathological process due to the presence of catheter. Presence of albumin, variation in sp.gr. and rare presence of epithelial casts and cells during postoperative period did not manifest any significant clinical symptom.

The indwelled polythene catheter retained for varying periods of 13 days to 46 days. Noordey (1963) and Hastings (1965) have reported indwelled catheter being retained in bladder normally for three to four weeks and rarely for a year. Desmond (1950) stated to have retained stainless steel 'T' cannula for three months.

In the present experiment the catheter was anchored
with urethral wall. In urethra the catheter has to stay against the pressure of urine while in bladder no such force acts against catheter. Moreover, there is much difference in availability of space for anchoring in bladder and urethra. The metal 'T' canula remained in position by virtue of its two arms fixed in urethral lumen.

The reasons for dropping down the catheter can be attributed to the following factors:-

(a) The anchoring suture gradually cut through the tissues by the sustained force of urine, flowing through the catheter.

(b) The healing tissues lying below the anchor, pushed the suture outward instead of growing over the thread which would have given firmer grip.

(c) Tissues failed to grow over the polythene base.

(d) The catheter was anchored in a way that it dropped down, when tissues could not hold it.

(e) Absence of wound infection except in one case, goes to prove that dropping of catheter can not be attributed to infection.

From the results of the study, it can be inferred that an indwelled catheter can be retained for two to three weeks. The period of indwelling catheter can be easily utilised for any additional surgical measure on urethra. Radical operation at sigmoid flexure or below for extraction of calculi can be undertaken after indwelling catheter in ischial urethrotomy.
opening. Khan (1963) has also practised this procedure. The advantage of this technique can be taken for conditions requiring by passing of urethra and urinary diversion below the ischial region like - balanoposthitis, severe injury to sheath and penis, early cases of rupture of urethra, in operation for urthral stricture and bladder paralysis.

In twelve buff calves closure of urethral fistula was observed. The period of gradual constriction and closure of fistula ranged from one to two weeks. The flow of urine from it was in the form of a stream which carried the urine away from the body. This prevented the excoriation of skin in most of the experimental animals. A fibrous stalk had developed encapsulating the catheter. When the catheter dropped down this stalk became patent and acted as an organised wall of the fistula. This prevented the infiltration of urine in the interposed tissue and helped urine to flow in a regular stream. Development and presence of fibrous stalk may have some far reaching consequence. One important question might arise regarding difficulty in protrusion of penis during service in the future reproductive life of the entire male animal operated with this technique. It may be noted that the part of the penis to which stalk is adherent, is the fixed part of the organ and hence the deemed difficulty can be ruled out.
SUMMARY
SUMMARY

Incidence of bovine urolithiasis and its nature, during the period of April, 1964 to October, 1967, was surveyed in six districts of Rajkot Region of Gujarat State. Total number of incidences were 2322. Two important factors in the nature of incidence have been revealed, namely a high incidence during the summer season and high incidence in one year age group. The incidence in young calves under ten months of age was significant. More number of incidence was found in area with lime stone. The highest number of incidence were recorded in castrated animals. Only 26 incidences were recorded in non-castrated animals. This confirmed the findings of many previous workers. Low incidence in the bullocks of Gir breed and practically absence of the same in the male buffalo, is noteworthy.

Feeding the byproducts of ground nut, has any bearing or not, requires experimental investigation.

The qualitative chemical analysis of the calculi collected from the same region was carried out, which confirmed the presence of calcium, magnesium, oxalates, phosphates and carbonates in various calculi. Uric acid group and silica were found to be absent.

A polythene catheter of a suitable diameter for the present study was tried successfully, for indwelling in urethra after ischial urethrotomy in all 18 animals. The
polythene catheter was prepared from common tubing at a very low cost of thirty paise per piece. This can easily be available for field practice. The catheter material proved to be non-toxic, non-reactive and non-adhesive in urethral lumen. It was found non-erosive when fixed in one position, and water repellent. Its rigidity and inability to autoclave it, are the drawbacks of polythene.

Ischial urethrotomy was performed in 18 experimental buffalo calves and polythene catheter was indwelled successfully. The operation was performed both under local and epidural anesthesia. The site of incision, one inch below the bony ischial arch, was found suitable. The technique of operation and method of insertion, indwelling and anchoring catheter was discussed. It was found possible to close urethral and skin incision after indwelling catheter and this helped the wound to heal without usual complications except in one animal. This proved to be the most important advantage of the method. The major quantity of urine drained through catheter which also helped the wound to heal. 99 percent success was achieved by employing the modified technique of indwelling catheter. No parenteral antibiotics were administered.

The catheter retained for two to three weeks, generally without infection. The urinary fistula was well organised because of the fibrous encapsulation of the catheter in the interposed tissue. The fistula closed within one to two weeks, except in one buff calf in which complete blockage of
urethra had resulted.

Ischial urethrotomy affords immediate relief by evacuation of the bladder, possibility to locate calculi and facility to flush urethra and the bladder. By indwelling catheter, the operation becomes rational and readily acceptable. Operation at sigmoid flexure or below, can be performed, after indwelling catheter. It prevented urine infiltration and subsequent complications. This resulted in quick and uneventful healing of the wound. Local ascending and cross infection could be prevented.

Fibrous stalk, encapsulating catheter developed, which proved beneficial during closure of fistula. No other significant pathological lesions were found, except proliferation of epithelium and increased fibroblastic cellularity in lamina propria of the urethral mucosa.

The advantages of ischial urethrotomy and indwelling polythene catheter were studied and discussed.
Photo No. 1:
Urethral calculi of various shapes.

Photo No. 2:
Urethral calculi of various sizes.
Photo No. 3:
Folded urethral mucosa showing transitional epithelium H.E. 10 X 10.

Photo No. 4:
Corpus cavernosum urethrae and mucosa.
Photo No. 5:
Skin incision, wound lips retracted with Allis forceps.

Photo No. 6:
Retractor penis muscle and penis exposed.
Photo No. 7:
Two parts of Retractor penis muscle drawn apart.

Photo No. 8:
Anchor suture applied.
Photo No. 9:

Anchored catheter in situ. Note the drops of urine in the catheter.

Photo No. 10:

Skin incision closed. Catheter fixed in the lower commissure of the wound.
Photo No. 11:
Buff calf urinating through the indwelled catheter.

Photo No. 12:
Fibrous stalk at the site of incision.
Photo No. 13:
Opened bladder and urethra. Note congestion at the urethral opening.

Photo No. 14:
Proliferated epithelium with leucocytic infiltration in pelvic urethra.
Photo No. 15:

Skin adhered to penis by fibrous stalk. Note the linear scar and fistular opening on the skin.

Photo No. 16:

Opened urethra. Note the healing on the mucosa.
Photo No. 17:

Cross section through the penile urethra showing stratified epithelium
H.E. 10 X 40.

Photo No. 18:

Opened urethra. Note healing of mucosa in depression.
Photo No. 19:

Cross section of penile urethra. Note the unilateral proliferation of mucosa and increased fibroblast.

Photo No. 20:

Opened urethra. Note the healing of mucosa.
Photo No. 21:
Cross section through penile urethra showing absence of reaction in mucosa HE 10 X 40.

Photo No. 22:
Cross section of penile urethra showing stratified proliferated epithelium with leucocytic infiltration. H.E.
Photo No. 23:
Buff calf no. 5 urinating through the catheter.

Photo No. 24:
Buff calf no. 5 urinating through the fistula.
Photo No. 25:

Well organised fistular opening.

Photo No. 26:

Cross section of healed up urethral wall. Note the fibroblast. H.E. 10 X 40.
Photo No. 27:

Buff calf No. 16. Indwelled catheter in position.

Photo No. 28:

Opened urethra. Note the circumscribed depression on the mucosa.
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