A STUDY OF EARLY EXPERIENCE WITH THE USE OF BUCCAL MUCOSA FOR SUBSTITUTION URETHROPLASTY

Dissertation submitted to

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In partial fulfillment of the regulations

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M.Ch. BRANCH - IV

UROLOGY

GOVT. STANLEY MEDICAL COLLEGE & HOSPITAL

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CERTIFICATE

This is to certificate that dissertation titled **"A STUDY OF EARLY EXPERIENCE WITH THE USE OF BUCCAL MUCOSA FOR SUBSTITUTION URETHROPLASTY"** of **Dr.M.Rajasekar** in partial fulfillment of the requirements for M.Ch. Branch -IV (urology) Examination of the Tamil Nadu Dr. M.G.R Medical University to be held in August 2013.

The period of study was from October 2011 -February 2013.

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DECLARATION

I, **Dr.M.Rajesekar** solemnly declared that dissertation titled **"A STUDY OF EARLY EXPERIENCE WITH THE USE OF BUCCAL MUCOSA FOR SUBSTITUTION URETHROPLASTY"** is a bonafide work done by me at Govt. Stanley Medical College & Hospital during October 2011 to February 2013 under the guidance and supervision of Unit Chief **Prof.Dr.V.Selvaraj, M.S., M.ch. (Urology)**Professor and Head Of The Department.

The dissertation is submitted to Tamil Nadu, Dr. M.G.R Medical university, towards partial fulfillment of requirement for the award of M.Ch. Degree(Branch-IV) in urology three years course.

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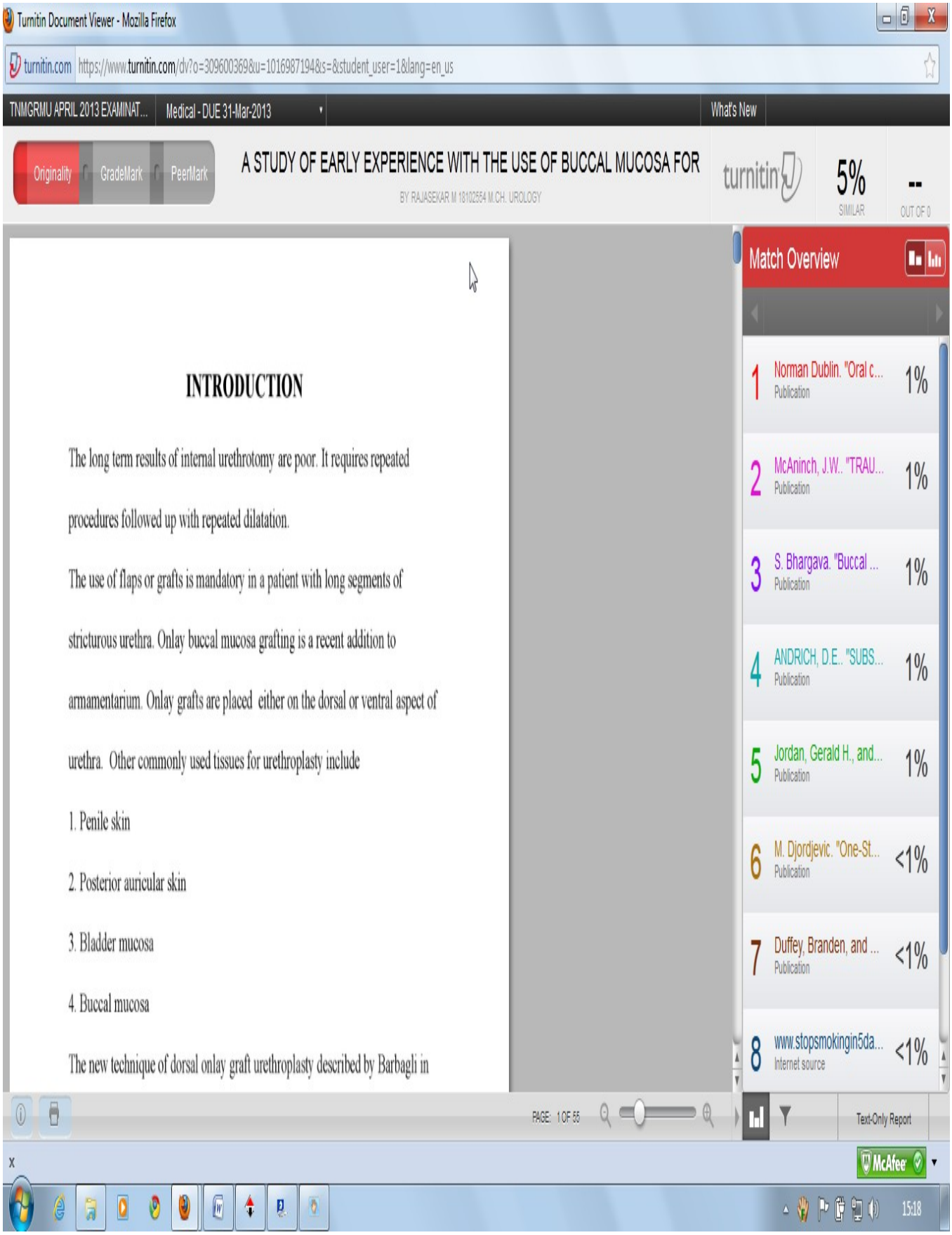
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INTRODUCTION
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The use of flaps or grafts is mandatory in a patient with long segments of stricturous urethra. Onlay buccal mucosa grafting is a recent addition to armamentarium. Onlay grafts are placed either on the dorsal or ventral aspect of urethra. Other commonly used tissues for urethroplasty include
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2. Posterior auricular skin
3. Bladder mucosa
4. Buccal mucosa
The new technique of dorsal onlay graft urethroplasty described by Barbagli in
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The request for an approval from the Institutional Ethical Committee (IEC) was considered on the IEC meeting held on 12.10.2011 at the Modernized Seminar Hall, Stanley Medical College, Chennai-1 at 2PM

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INTRODUCTION

The long term results of internal urethrotomy are poor. It requires repeated procedures followed up with repeated dilatation.

The use of flaps or grafts is mandatory in a patient with long segments of stricturous urethra. Onlay buccal mucosa grafting is a recent addition to armamentarium. Onlay grafts are placed either on the dorsal or ventral aspect of urethra. Other commonly used tissues for urethroplasty include

1. Penile skin

2. Posterior auricular skin

3. Bladder mucosa

4. Buccal mucosa

The new technique of dorsal onlay graft urethroplasty described by Barbagli in 1995 has been greeted with great amount of enthusiasm through the world.

The reported success rate was around 93-96% with a follow up of 20-35months. In this study, we have attempted to extend the use of the buccal

mucosal graft procedure for management of long anterior urethral strictures including pan urethral strictures.

HISTORY

HISTORY

Suprechko, in 1886, was the first to describe the use buccal mucosal graft. Before the era of antibiotics, the post-operative results with this graft were poor. In 1980, Duckett reported using the buccal mucosal graft in epispadias repair. Barbagli proposed the dorsal placement of buccal mucosal graft and evaluated the post-operative complications of buccal mucosal grafting.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Anatomy:

- The parts of male urethra are :

    1. Anterior urethra

    2. Posterior urethra

- The parts of anterior urethra are

    -fossa navicularis

    -penile urethra

    -bulbar urethra

- Parts of the posterior urethra are

    -membranous urethra

    -prostatic urethra

The corpus spongiosum spongy tissue lies in the ventral aspect of corpora cavernosa and it surrounds the urethra. Corpora cavernosa has more erectile tissue and a thicker tunica albugenia. Corpus spongiosum has lesser erectile tissue and thinner tunica albugenia.

The tough Bucks' fascia immediately surrounds the tunica albugenia. The Dorsal aspect of Bucks' fascia contains

1. Dorsal nerves.

2. Dorsal arteries which are two in number.

3. Dorsal vein which one in number .

Bucks fascia covers the corpora cavernosa completely. But it is divided into two layers around the corpus spongiosum .Bucks fascia is attached distally to the glans penis. It is attached proximally to perineal membrane(inferior fascia),pubis and ischium. Anterior urethra extends from inferior fascia of urogenital diaphragm to the external meatus of penis.

Fossa navicularis is contained within the glans penis. Penile urethra is completely surrounded by the corpus spongiosal tissue. Anatomically it starts distal to the ischiocavernosus muscle.

The two parts of ischiocavernosus join in the midline and cover the bulbous urethra, which in turn is surrounded by bulbous spongiosus and corpus spongiosus.

Lining epithelium of male urethra:

-Prostatic urethra: transitional cell epithelium

-Membranous, bulbar, penile urethra: stratified or pseudo stratified columnar

-Fossa navicularis: stratified squalors epithelium.

Histology

Urethra has three layers :

1. Mucosal layer.

2. Sub mucosal layer.

3. Muscular coat layer.

I. Mucosal layer:

As previously mentioned various parts of urethra are lined by various types of epithelial lining.

II. Sub mucosal layer:

It extends throughout the length of the urethra. It has rich vascular and erectile tissues

III. Muscular coat:

Muscular coat of prostatic and membranous urethra is a downward continuation of detrusor muscle layer of the bladder. It is innervated by sympathetic nerve fibers. The sphincter urethra was formed by the striated muscle layer. It is surrounds the membranous urethra.

ARTERIAL SUPPLY: Common penile artery supplies the deep structures of the anterior urethra. Internal pudental artery usually given branches to perineal structures. After giving rise to the perineal branches it continues as the common penile artery. The artery travels along the level of the medial margin of the inferior pubic ramus.

The Common penile artery gives rise to the following branches;

1. Bulbourethral artery

2. Dorsal artery

3. Tiny branches from deep arteries of penis.

Bulbourethral artery is a short artery but has a large luminal diameter. It goes to the bulbospongiosus muscle and supplies it. It courses along the side of membranous urethra.

Dorsal artery lies in the Bucks fascia. It is related medially to the dorsal vein and laterally to the dorsal nerves. In the flaccid penis it is highly coiled and tortuous. It becomes uncoiled when the penis is erect. It gives off 3-10 circumflex branches. It accompanies the circumflex vein which is present laterally. Its terminal branches are divided and distributed throughout the glans penis.

Superficial Perineal space:

It lies in the urogenital region. The contents of this space are :

1. root of penis(crura&bulb).
2. arteries : posterior scrotal artery and transverse perineal artery and 4 branches of artery of penis(artery to bulb, artery to urethra,deep&dorsal artery)
3. muscles (superficialtransversperinei, ischiocavernous, bulbospongiosus),
4. nerves(posterior scrotal nerve, nerve of bulb, muscle branches, long perineal nerve)
5. ducts and gland(bulbourethral gland ducts, greater vestibular glands in female).

Its boundaries are as follows: superficially by Colles fascial layer; on either side by the ischiopubic rami; deeply by the perineal membrane; posteriorly the space is closed by the union of perineal membrane; anteriorly it is open and continuous with the scrotum.

Stricture disease

Etiology;

Stricture most commonly affects the anterior urethra. Various factors are involved .The most common causes are listed here.

1. Inflammatory disease of corpus spongiosum like Balanitis Xerotica Obliterans (BXO), post gonococcal strictures.

2. Post Endourological surgey : in these cases ischemia was the most common reason to produce stricture.

3.Blunt trauma to perineal area leading to healing of injury with scarring is a common cause.

3. Failure of hypospadias repair.

4. Congenital anomalies affecting the mucosal membrane of bulbar urethra can also produce stricture. But on detail examination, the corpus spongiosum is usually not involved.

Pathogenesis

Though the pathology of urethral strictures may be simple at times, the exact cause of many strictures remains unknown. Even though there may be an antecedent history of gonococcal infection in the patient with stricture, it remains unclear whether the stricture occurs immediately following an attack of gonorrhoea. Usually, the time lag between gonococcal infection and presentation of stricture could be considerable. In most cases of stricture, there is no direct relation between an infective source and trauma to urethra . In patients with urethral stricture disease on anatomical review, Chambers et al., noted changes in the urethral epithelium. Normally the epithelium of the urethra is of pseudo stratified columnar type. In patients with stricture, this epithelial type changes to columnar type. This columnar epithelium does not have tight water proofing quality. As a result, extravasation of urine can occur in this type of epithelium. This repeated extravasation of urine causes the urethral fibrosis.

Partial loss of urethral lining is also an important factor predisposing to stricture formation. Since there is exposure of the spongiosal vascular spaces to the passage of urine , superficial spongiothrombosis can occur. This then progresses to form a layer of spongiofibrosis. The loss any portion of circumference of a epithelial lining generally results in commensurate

narrowing of the lumen during healing because the margins of residual epithelium are approximated by natural urethral closure pressure so that unepithelialized defects forms clefts that tend to heal by cross adhesion and epithelial over bridging. However intermittent passage of urine opens these clefts, and this repeated separation and re-exposure of the underlying vascular spongy tissue spaces – combined with relatively slow uroepithelial proliferation-leads to gradual increase in underlying spongiothrombosis and consequently spongiofibrosis and stricture formation.

Singh and Blandy studied the pathogenesis of inflammatory strictures. They proposed that fibrosis beginning initially in the corpus spongiosum was responsible for disease in the distal penile and mid bulbar segments of the urethra. The cause of fibrosis in the corpus spongiosum could be the result of direct urinary extravasation through the epithelium of the urethra. It could also be the indirect result infection in the urethral glands at specific sites. This infective / inflammatory process then subsequently extended into the corpus spongiosum. The fibrosis within the corpus spongiosum, once initiated lead to narrowing of the urethral lumen. Further micro-abscess formation can occur within the urethral glands if there is persistent infection. This in turn leads to worsening of fibrosis worse and extension of fibrosis to the peri-urethral region.

Urethra lined by waterproof pseudo stratified columnar epithelium

↓

Leaky columnar epithelium

↓

Extravasation of urine and spongiofibrosis

↓

Constriction of urethral lumen

↓

Micro abscess in urethral glands

↓

Periurethral extension of inflammation

↓

More severe stricture

Spongiofibrosis

The surgical significance of established urethral spongiofibrosis is its high predisposition to progress to stricture formation when it is inappropriately used in surgical repair. Thus it is the overall extent of the spongiofibrosis associated with a stricture and not simply the length of stricture itself-that should properly determine both the type and extent of a urethral repair required to achieve satisfactory long-term resolution. If the longitudinal extent of the urethral repair is limited only to the length that is

actually strictured, as opposed to the length of the spongiofibrotic abnormality, it commonly results in restenosis.

Severe spongiofibrosis changes are often palpable and they are generally apparent urethrographically by a scarred reduction in the caliber of the urethral lumen and by the excavation of the ducts of the glands of the Littre and Cowper. Endoscopically, spongiofibrotic urethra has a whitish colour-quite distinct from the normal urethra that is pink because the underlying vascular spongy tissue is seen through the translucent covering of the urothelium. However preoperative evaluation even by the use of sonourethrogram offers only a guide line- the critical extent of the surgically significant spongiofibrotic urethral abnormality may not be apparent until it can be accurately determined by direct inspection at the time of operation , when the urethra has been opened .By the extending the incision into the healthy and truly pink urethra proximally and distally , the area of stricture is revealed as a well-defined thin layer of sub epithelial fibrosis that is clearly distinguishable.

In stricture of the urethra both the upper urinary system and lower urinary tract system are affected. Progressive increase in voiding pressure occurs due to narrowing of urethral lumen. This pressure change leads to damages in both the lower as well as upper urinary tract system .The

obstruction also gives rise to secondary infection very commonly. This secondary infection usually affects the prostate and epididymis. Upper urinary tract complications are less commonly seen in the below fifty year age group.

INVESTIGATION:

A variety of investigative tools are available. These include:

1. Contrast studies (ascending urethrogram, micturating cysto urethrogram, antegrade study through supra pubic catheter.)
2. Sonourethrogram.
3. MRI.
4. Voiding CT urethrography.
5. Uroflow studies (to assess the obstructive flow pattern).

In ascending urethrogram we can identify the stricture site and the length of stricture. A good quality ascending urethrogram requires scout film KUB , proper positioning of patient, good stretching of penis and non-overlapping of operator. Dilute contrast must be avoided and use of high pressure during contrast injection should also not be done. If the external meatus shows tight narrowing, the contrast study should be done through a

supra pubic catheter. The study should preferably be done under fluoroscopy. If it is done under image intensifier , we can assess the stricture very clearly.

Next investigation used in studying a stricture is sonourethrogram .It is not done routinely. The commonly used probe is 7.5MHz frequency. Compared to the ascending urethrogram, the sonourethrogram can assess the length of stricture very accurately. This is because the ascending urethrogram fore shortens the length of urethra. Sonourethrogram can assess the degree of spongiofibrosis and depth of spongiofibrosis. Severity of stricture corresponds to the urethral luminal diameter. Its main disadvantage are 1.difficult to assess the posterior urethra.2. high cost 3.expertise required.

Magnetic Resonance Imaging:

It is an infrequently used procedure and also costlier compared to other methods. It is also more difficult to do.

Its main clinical uses are:

1. To study posterior urethral injury.

2. Assessing the periurethral soft tissue.

Information gained is as much as that with conventional imaging. Sterile saline or gadolinium (1:200) can be instilled in to the urethra for imaging. Special MRI compatible penile clamps are also available for use.

Voiding CT Urethrogram:

It uses multidetector CT for urethral assessment. It assesses the length of stricture and site of stricture involvement. For CT urethrogram, bladder should be filled with contrast. It can also be done as part of an IVU study. The contrast is filled via urethra or through the suprapubic catheter. Scanning is started once the patient is ready to void.

DISADVANTAGES OF CT URETHROGRAM:

1. No clear advantage over conventional imaging.
2. Risk of intravenous contrast allergy.
3. Gonadal radiation.
4. Anterior urethra is not adequately distended during voiding.

U**roflowmetry :**

It is a non-invasive test. It is very simple to do. It measures voided urine volume/unit time. It is a functional study of urethra and bladder. It measures urinary flow rate. It is an indicator of urethral resistance and detrusor contractile function. The urinary flow rate can be modified by various external factors. As a result, it provides insight in to voiding function as a whole, without differentiating each of the components of voiding.

The components of uroflow device are uroflowmeter, transducer and recording device. Ultrasound is necessary to measure the post void urine. The uroflow room should have adequate privacy so that the patient may void comfortably.

The common types of uroflowmeter are disc flow meter (rotating type), capacitance type and weight transducer type flowmeter.

Disc flow meter : In this type, the urine directly falls on the spinning disc. The disc is maintained at a constant speed of rotation by a servometer. The flow rate is directly proportional to the weight of the urine that falls on the disc per unit time. This System is least likely to produce artifacts.

Capacitance type Flow meter : This is based on the dip stick integrated system. Values are measured as dip stick capacitance directly proportional to the height of the urinary column. The main disadvantage is

that the system needed to be calibrated repeatedly as it had a tendency to go out of calibration .

Weight transducer flowmeter : The flow rate is calculated in this system by weighing the volume of urine voided. It is represented with respect to unit time. The weight of urine is usually less than three percent of the weight of water. This allows it to be equated to volume and calculated as a flow rate.

In stricture disease, the pattern of flow is of constrictive type. In severe stricture disease, the pattern is a typical plateau shape. It is usually very good for follow up studies and can be repeated several times.

MANAGEMENT :

Various methods to manage stricture disease are present .Each procedure has its own advantages and disadvantages which were reviewed by several authors. Internal urethrotomy and dilatation have been reviewed. These two procedures have no advantage over one another. Only during the first time management of stricture did these two procedures have some good results .On long term follow up however these two have high failure rates. Subsequent second and third procedures had high immediate failure rates. Internal urethrotomy and dilatation have reasonable success rate only in short

bulbar strictures. Use of these procedures for multiple strictures, long strictures and strictures of penile urethra are associated with a very poor success rate.

Various procedures have been attempted to improve results of stricture disease. These include laser urethrotomy, and use of urethral stents. In laser urethrotomy, vaporization of fibrous part stricture disease is done. Commonly used lasers in stricture urethra are Nd;YAG laser, KTP LASER and Holmium;YAG laser. Laser urethrotomy show no better results over internal urethrotomy by cold knife. Results decline with time. It is usually used in pediatric strictures, and short segment strictures presenting for the first time. Another method used for treating stricture is with urethral stents .Two types are present. One is the temporary type and the other is permanent stent. Both produce discomfort, post void dribbling of urine, pooling of semen, recurrent infection, tissue ingrowth and have high failure rates. The next method of managing a urethral stricture is self-urethral dilatation. The patient initially responds to dilatation and does the dilatation regularly. But on longer follow up, it has been observed that the patient avoids doing the dilatation regularly, because of discomfort. As a result, recurrence of stricture is common. Hence, best method of management in urethral stricture disease is urethroplasty.

Another method of treating strictures is by medical management. Most of the patients with stricture have had prior infection of urethra. In gonococcal urethral infection, appropriate antibiotic therapy provides good results. For gonococcal infection, ceftriaxone provides better results. For chlamydial urethral infection, doxycycline gives the best results. Treatment of acute infection does not necessarily prevent the future development of urethral stricture. But if antibiotic treatment is statered early, good results can be expected. Variety of drugs are available for intraurethral application in case of long stricture disease. Intra urethral steroids can be applied weekly for long anterior urethral stricture disease. Another method of steroidal therapy is use of super steroid .In this method clobetosol 0.05 percent is applied locally twice a day for a minimum of six to eight weeks . For stricture disease with acute infection ciprofloxacin or doxycycline for three weeks can be given. It controls acute infection to a certain extent so as to prevent disease progression. Drugs can be given post operatively after endo procedures to prevent recurrence .Intra urethral triamcinolone can be used after internal urethrotomy. But long term results are not good. Topical application of tacrolimus has been tried in female patients with stricture urethra. Short term response appeared good. Another new drug being tried is halofuginone . It is an oral inhibitor of type 1 collagen .It has limited clinical value because recurrence of strictures, new stricture formation is found to be common.

Another drug tried in stricture disease is Botulinum toxin injection into the scared tissue of the stricture .This has been postulated to decrease the scar formation in stricture but clinical trials and results are limited. Mitomycin C intra urethral application has also been tried. It has fibroblast proliferation inhibition properties. Low dose was used but long term results not good. Acitretin is a second generation orally active retinoid. It has keratolytic properties. Retinoids are structurally similar to vitamin A. It is involved in growth of normal skin cells. The detailed mechanism of action of acitretin is not known .It probably acts by retinoid receptor inhibition. It has been clinically used in lichen sclerosis of the external genitalia. The dose of the drug is thirty milligram daily, given orally. But long term results for this drug are not available and its clinical use is limited by its toxic complications.

Balanitis Xerotica Obliterans (BXO)

As a cause for stricture urethra, BXO needs special mention. Balanitis xerotica obliterans was described first in the year 1928 .It is one form of lichen sclerosis. Its incidence is one in three hundred[4]. The main etiology of this disease is unknown. The commonly affected area in the external genitalia is glans penile area and prepucial skin. The lesion can extend up to the bulbar urethra proximally. Due to the extensive involvement of the urethra, the best method of management is surgically excision of the entire affected urethra

and substitution with buccal mucosal graft.But it has a very high morbidity and high failure rate of around sixty five percent.

Surgical procedure recommended for anterior urethral stricture according to the length of the stricture is as follows : [3]

SURGERY OF STRICTURE URETHRA

Length of stricture	Type of procedure
1-2cm bulbar urethral stricture	End of end urethroplasty
2-3cm	Augmented roof top anastomotic urethroplasty
3-6cm	Augmented dorsal or ventral on lay graft urethroplasty
>6cm	Staged urethroplasty.

Various methods of urethroplasty are available. One of the method is end to end urethroplasty. This procedure is done in cases of post traumatic stricture urethra. In urethroplasty by substitution methods ,various tissues are used (buccal mucosa ,bladder mucosa, rectal mucosa ,penile skin).It is done by either augmentation method or dorsal or ventral on lay procedure.

Poor prognostic factors for Urethroplasty are

1. Periurethral fibrosis
2. Poor vascular supply
3. Periurethral phlegmon
4. Poor tissue availability
5. Previous instrumentation
6. Long stricture
7. Balanitis xerotica obleterans(BXO).

In the presence of risk factors staged urethroplasty is advocated.

Graft take

Graft take occurs in two phases-imbibition and inosculation. It takes 96hours. The first phase of graft take is called as imbibition. This phase is very important. During this phase, essential nutrient supply is got from tissue host bed. During the imbibition phase the temperature of the graft is less than the surrounding tissue. In response to growth factors produced by the hypoxic vessels, buds are produced from arteries, veins and lymph channels in the vascular bed. These new vessels grow through the fibrin matrix that has

formed between the graft and graft bed and penetrate the graft to hook up with the vessels in the sub dermal and intradermal plexus, reperfusing the grafted skin. During inosculation, neovascular genesis takes place so the graft gets its vascularity. Due to new vessel formation the temperature of graft becomes equal to the body temperature. The graft take is based on the type of graft, technique of harvesting, absence of infection and local vascularity of the host bed tissue.

Anant kumar et al [4] have made a review about their management of BXO by single stage or multi stage procedures. They had complications like graft loss. Stomal revisions and glans cleft narrowing were noted in 5 out of 14 of their staged urethroplasty patients. None of their 25 single stage urethroplasty patients had similar problems. Recurrent stricture was noted in 21.4% of their two stage of urethroplasty patients and in 12% of single stage urethroplasty patients.

Jean V.joseph et al.,[5] on reviewing their 38 staged urethroplasty patients, found that no patients under went revision of stage I urethroplasty while 8 underwent revision of stage II of urethroplasty. He concluded by saying, "II stage urethroplasty is often converted into multi stage procedure ". A single patient required three revisions for stage I procedure before he became fit for stage II procedure.

Ezo palminteri et al., [28] concluded that stage II urethroplasty patients are exposed to repeated anesthesia and risk of morbidity. These multiple procedures were also associated with psychological trauma to the patients.

Revisions are common with staged urethroplasty and in approximately 50% of patients a 2 –stage procedure will turn out in practice to be a 3 stage one. Penile urethroplasty is particularly susceptible to revision. It has restricture rate of 4% at 6months follow up even in the best of hands[11].

Grafts are placed preferably dorsally in case of anterior urethral stricture disease because

1. The graft is placed over corporal bodies which carries the following advantages:

    - Good support and prevents sacculation and pouch formation
    - Good vascular bed potentiating graft takes.
    - Good immobilization of the graft
    - Less chance for graft shrinkage and chordee[7]

- A potential for roof strip epithelial regeneration according to the principles of Duplay, Davis, Traut, Brown, Weaver and Schulte, Moore and Monsieur[12].

2. Urethrocutaneous fistula can be prevented by adequate duration of indwelling catheter

3. It preserves residual blood supply of the corpus spongiosum[7]

4. In case of bulbar urethra it requires less extensive opening of spongy tissue and urethra is position dorsally.

M.T.El-Sherbuny et al., [30] conducted a study in dogs using buccal mucosal graft urethroplasty and found that BMG shrinkage was less than 10%. When compare to full thickness skin graft and bladder mucosal graft, buccal mucosal graft had less inflammation, less fibrosis and uniform graft thickness at three months after grafting.

Buccal mucosal graft

The uniqueness of buccal mucosa and its histologic and antibacterial properties make it the superior tissue for reconstruction. The unique structure of the buccal mucosa allows it to be an excellent grafting material. It is 500micro meter thick and is a nonkeratinized, stratified squamous epithelium

consisting of four layers. The stratum basale or germinative layer of the epithelium rests against the basement membrane and provides the progenitor cells for cellular division. The basale layer is two or three cell thick and includes melanocytes and antigen presenting Langerhans cells, sensory merkel cells, and lymphocytes. It has a rapid turnover rate with only 25 days required for all layers of buccal mucosal epithelium to be replaced.

The stratum spinosum is the next layer. This provides intercellular bridges that give the buccal mucosa the prickle appearance in light microscopy. The outer two layers (stratum intermedium and superficiale) are difficult to delineate from each other. These cells are however unique in that they are more firmly attached to each other than cells of other keratinized tissue, thus providing excellent barrier protection.

In the buccal mucosa, deeper to the epithelium the lamina propria layer is situated. This lamina propria layer contains high amount of elastin and collagen. Elastin fibers are more numerous in the buccal mucosa than in other tissues allowing buccal mucosa to recoil after stretching. The lamina propria further provides long slender papillary invaginations into the epithelia and loose collagen fibers and loops of capillary from which the epithelium gets its blood supply. The web like reticular layer of lamina propria holds the

vasculature and nerves of the buccal mucosa. Collagen, elastin and ground substance depend on the fibroblast that also resides in the area.

The line between the sub mucosa and the lamina propria is difficult to delineate. The sub mucosa which is firmly attached to the underlying buccinator muscle is also rich in collagen and elastin. A major salivary glands duct (stensen's duct) from the parotid gland pierces the buccinator muscle opposite the maxillary second molar bilaterally.

The arterial supply to the buccal mucosa originates from the facial artery, the buccal artery , posterior superior alveolar artery and inferior superior alveolar branch of the external carotid.

Buccal mucosa is an ideal substitute for urethra because

1. Buccal mucosal epithelium has higher amount of elastin content .So it is durable and easy to use in surgical procedures.[7]

2. High amount of type IV collagen content[8.]

3. Helps in good graft take.

4. Buccal mucosal lamina propria is a very thin layer .This character is very useful in inosculation and new vessel formation after surgical graft.

5. It has a pan laminar plexus which is thinner in nature. This physical characteristic is based mainly on the deeper laminal layer.

6. It has high capillary density[7].

7. The graft carries a wet epithelial surface[32].

8. Thickness of BMG makes it easy to handle.

9. It is a better substitute in case of BXO[10].

10. Harvesting of BMG is easy and it is also easy to apply[7].

11. Large volume is available[7].

12. It heals without much pain.

13. There is no visible scar or deformity[34].

14. Graft contracture is<10%[34]

15. Resistant to progression of skin diseases like BXO [39].

16. Donor site re-epithelialized within 2 weeks[35].

17. It is resistant to infection[34].

18. Of the free grafts used by McAninch the longest successful grafts were those from the buccal mucosa (BMG was not used for penile urethra)[13].

Inner cheek is the preferred site of buccal mucosa graft harvesting as it gives a broader, thicker and more resistant mucosa.

Bargava et al.,[12]have produced tissue engineered buccal mucosa graft from a small buccal mucosal biopsy to produce 1or 2 2/10cm patches of tissue engineered buccal mucosal graft. Time required to produce a tissue engineered buccal mucosal graft was minimum five to six weeks. Tissue engineered buccal graft also has good tissue and mechanic properties like native buccal graft.

Peroperative and postoperative complications;

During buccal mucosal harvesting, life threatening complication is very rare. Till date no harvesting site significant complications have been reported.

Possible adverse effects of buccal mucosal harvesting

1. Peroperative bleeding.

2. Injury to the Stensen duct (parotid).

3. Postoperative oral cavity wound infection.

4. Pain.

5. Swelling of the cheek.

6. Limitation of mouth opening.

7. Nerve injury leads to total sensory loss or altered sensation of lower lips.

Avoiding of injury to the surrounding structure is by pre-operative planning and marking of buccal mucosa on table before harvesting. In order to avoid parotid duct injury the dissection of buccal mucosa should start at least one centimeter from the parotid duct opening and also careful suturing during wound closer is required. Other problems during harvesting of buccal mucosa include intra operative hemorrhage, postoperative infection, pain, swelling, damage to the parotid duct, limitation of oral opening and loss or altered sensation of the cheek or lower lip through nerve damage. In comparison to the lip graft, cheek graft has less morbidity to the patients. Altered sensation is the most common complication following buccal mucosal graft. Clinically it is transient in nature.

Study of Dublin and Stewart [22] reported fifty seven percent of patient's year. Caldamone et al., reported that 2 patients developed wound contractures at the harvesting site. In the study by Dubey et al, there was only one reported

patient who developed bleeding complication and also needed surgical intervention. In both series harvesting graft area was cheek &lower lip.

Compared to usual skin graft, buccal mucosa is a better alternative because of its properties like easy handling, lesser infection, and a very good response to wet environment. The buccal mucosal graft can be applied to all type of strictures. With medium term follow up, the outcome compared to skin graft is that buccal graft has lesser complications and lower harvesting site morbidity.

Because of its clear advantages, buccal mucosa has become the best source of tissue for substitution urethral reconstruction. Long term results are awaited.

N.P.Gupta et al.,[19] reviewed their experience in treating long anterior urethral strictures patients .Total no. of patients in the study was twelve. Treatment of the long anterior urethral stricture was by single stage urethroplasty. In this ventral sagittal urethrotomy was made and buccal mucosal dorsal onlay was done. Only a small perineal incision was made and eversion of penis was done through a perineal incision. No urethral dissection was attempted. Hence no vascular compromise is seen. The average stricture length was five centimeter in length. The mean follow up duration was twelve months. They have used micturating cystourethrogram at 21stpost-operative

day, and in the presence of leak they have retained the catheter for two more weeks for one patient.

Out of twelve, 11 patients showed very good results. Only one patient needed visual internal urethrotomy for stricture at proximal anastomotic site. Through minimal perineal approach, dorsal buccal mucosal graft is an easy procedure with very good surgical results. In this method there is no need for urethral mobilization. As a result there is a very good preservation of urethral mucosa.

Barbagli et al.,[42] reviewed dorsal on lay skin graft urethroplasty. Total number of patients studied was forty five. Average age of patients was forty five. In this study ,23 patients had undergone previous endoscopy treatment.

All patients were evaluated by complete clinical history, systemic examination, anterior urethrography, voiding urethrogram, and sonogram of KUB.The operative procedure included opening of bulbar urethra on the dorsal surface. The graft was quilted, splayed and sutured on the dorsal surface of corpora cavernosa. Penile skin was used as graft material for all patients. Mean graft length was 4.5centimeter.Followup postoperative voiding cystourethrogram was done on 21st postoperative day. The average follow up was seventy one months. Failure was considered as the need for post-operative instrumentation including dilatation. The overall success rate was

73% and failure rate was 27%. The 12 patients who failed were clinically evaluated and treated. One patient underwent internal urethrotomy, one patient underwent end to end urethroplasty and two underwent skin graft plasty. Two stage urethroplasty was done in six patients. Out of twelve patients, six patients had better outcome. The other 6 patients were not willing for further surgical procedures and they ended up with perineal urethrostomy. Conclusion of this study was penile skin dorsal on lay had tendency to deteriorate with time. For comparing ,buccal mucosa and penile skin graft a long term follow up is needed.

M.Bhandhari et al[21] have reviewed their experience in the management of complex anterior urethral strictures. Their management of strictures was based on dorsal/dorsolateral placement of penile /preputial vascularized skin flap. They compared their procedure with the results of the usually placed ventral flap. Forty patients with a mean age of forty one years were studied. These patients presented with a recurrent stricture of the pendulous and/or bulbar urethra. They were evaluated and were then treated with a circumpenile flap or a longitudinal penile substitution urethroplasty. Dorsal placement of the flap as a on lay was performed in nineteen patients, whereas twenty-one patients had a ventral on lay repair. Five patients needed Inferior pubectomy was required in five patients. This was done to aid in high proximal placement of the flap. Both the study groups were similar with

regard to the age, site of stricture,length of stricture , number of previous interventions and also duration of follow –up. The median follow-up in this study was 27.5 months. Recurrence of the stricture was noted in three patients who had undergone (24%) ventral onlay .Two patients in the (11%) dorsal onlay group had a recurrence of disease (P>0.05). Surgical closure of the urethral fistula was required in one patient in the ventral onlay group. Six of the patients who had undergone ventral onlay flap placement developed complications of flap pseudo-diverticulum and sacculation with post void dribbling of urine while none of the patients in the dorsal onlay arm developed these complications (p=0.01). This study shows that when compared to the ventral onlay placement of flap , the dorsal placement of the pedicled flap is anatomically and functionally superior. Dorsal onlay preputial/penile flap urethroplasty is a very good procedure. It can be used for the management of even very long anterior urethral strictures. Even reconstruction of the meatus and high proximal bulbar strictures can be managed with this technique.

Mundy et al[41] in their study showed that for urethroplasty compared to patch grafts, use of buccal mucosal-free grafts provided superior results. Buccal mucosal grafts are tough and resilient. They were easy to harvest and handle, and they left no visible scar at the donor site. When compared to genital skin-free grafts or flaps,buccal mucosal grafts did not offer any

advantage in terms of cure of the stricture . But the advantage of the buccal mucosal graft is that they provide excellent cosmesis when compared to local genital skin. Another advantage of buccal mucosa is that, unlike skin, it is resistant to infection. In summary, buccal mucosa does not necessarily give better results in the long-term cure of urethral strictures; but it has many characteristics that make it the material of choice for patch urethrography. Hence unless there is a contraindication to use of free graft like poor vascularity or active infection at the site of the stricture, use of buccal mucosa is preferred.

George D Webster et al [44] reviewed their experience in twenty nine in whom augmented roof top anastamotic urethroplasty was done for stricture urethra. Stricture was noted in the bulbar urethra in all the twenty nice cases. Of these, six patients had a stricture that was completely obliterative. The mean length of the stricture in the study, on retrograde urethrography was 1.5 cm .The mean length of the excised segment was 1.2 cm. Nine of the twenty nine patients had their roof strip anastamosis augmented by a ventral onlay .In twenty patients a floor strip anastamosis was done with a dorsal onlay. Onlay used in the study included a pedicled skin flap in seven cases and a graft in twenty two. Mean length of the onlay was 4.5 cm. At a mean follow up of twenty eight months, ninety three percent of the patients were free of disease. All of the patients surveyed in the study were satisfied with the procedure.

Bergland et al [46] reported on eighteen patients. They had a mean stricture length of 15.1 cm . The defect was reconstructed using either a penile skin flap or a buccal mucosal graft.

Norman Dublin et al [22] studied thirty one patients. In the first forty eight hours after surgery, seventy three percent of the patients had little oral pain; seventy percent of the patients were able to eat while ninety percent of the patients were able to drink; numbness was noted in fifty nine percent and tightness of the mouth was observed in seventy five percent. When the patients were discharged six days after surgery ,ninety percent had little or no oral pain . They were all able to eat and drink. Ten percent of the patients however had moderate-to-severe oral pain.Oral numbness was observed in thirty nine percent. 52% of the patients had tightness of the mouth at the time of discharge. During a subsequent review of the patients, 16% complained of oral numbness (mean duration was13.6 months). Tightness of the mouth was reported by 52% (mean duration was 20.9 months). Seventy four percent of the patients responded ‘yes’ when asked whether they would have their cheek mucosa harvested again if required. 3% answered ‘no’ to this question, while twenty three percent had mixed feelings. Buccal mucosal graft harvesting was thus demonstrated to be a good option for the management of strictures, as most patients were satisfied with the outcome. It is, however, not without

long-term complication and patients should be adequately informed of the same when undertaking the procedure.

AIM OF STUDY

To evaluate the efficacy and early results of buccal mucosa graft in stricture of urethra.

Materials and methods

MATERIALS AND METHODS

It is a prospective study from October 2011 - February 2013. A total of 13 patients were enrolled in the study.

Inclusion:

1. Strictures >2cm involving anterior urethra.
2. Patient with comorbidity (DM/HT) were also included.

Exclusion:

1. Severe oral cavity infection
2. Mucosal ulceration
3. Mucosal fibrosis
4. Mucosal white or red patches severe perineal pathology.

The pre-operative work up included,

- General physical examination

- Examination of urethra for any mass.
- Glans penis examination.
- Perineum examination for peri urethral inflammation/any fistula.
- Dental opinion for oral cavity to rule out any oral pathology.

Pre-operative variable includes age of the patient, duration of symptoms, pre-operative uroflowmetry and previous cystoscopy findings. Past history of previous urological surgery and dilatation were also recorded.

Under nasotracheal intubation two teams[46] operated simultaneously in the oral cavity and perineum. Cystoscopy was done and stricture intubated with a ureteric catheter if possible. Perineum was explored with mid line perineum incision, which was bifurcated posteriorly to improve the access. Bulbar urethra was circumferentially mobilized after separating the bulbospongiosus muscle. Strictured urethra and approximately 1cm of normal urethra was mobilized proximally and distally. In case of pan urethral strictures (four patients)penis was invaginated and the urethra was separated from corpus cavernosum up to the meatus.

Urethra was rotated 180^0. The stricture was incised at twelve o clock position starting at the distal end of the stricture , proceeding proximally till a

healthy urethra is obtained. The healthy urethra should admit a 22-26 Fr bougie without difficulty.

At this level the length and the nature of surrounding tissue is assessed. Dorsal urethrotomy was done. The buccal mucosal graft was spread and fixed to underlying corpora cavernosa. The edge of the incised stricture was sutured to the graft as well as to the corpora cavernosa.

Buccal graft harvesting

Parotid duct identified with the help of methylene blue .Graft size is marked. Margins were infiltrated by using 1:1, 00,000 lignocaine in adrenalin. The graft was harvested sub mucosally with minimal fat. Harvesting site sutured with absorbable suture material. Depending on the requirement ,graft harvested was harvested from one or both cheeks .Once the graft was harvested it is put in a normal saline cup. It is then prepared for graft placement. Underlying fat is excised and quilting of the graft was done.

The graft was sutured over a 16Fr Foleys urethral catheter

The decision on the type of procedure to be performed and length of buccal mucosal graft needed was based only partially on the appearance and length of stricture noted on the Ascending urethrogram done preoperatively.

The final decision however was based on the intra operative findings such as length of stricture and appearance of the spongy tissue and mucosal layer.

The post operative management is as follows

1) Oral fluids on first post op day.

2) Semi solid diet after 48 Hrs.

3) Patient catheter removal on 21st POD

4) Follow up at 3,6 months We did uroflowmetry and if needed Ascending urethrogram and cystoscopy.

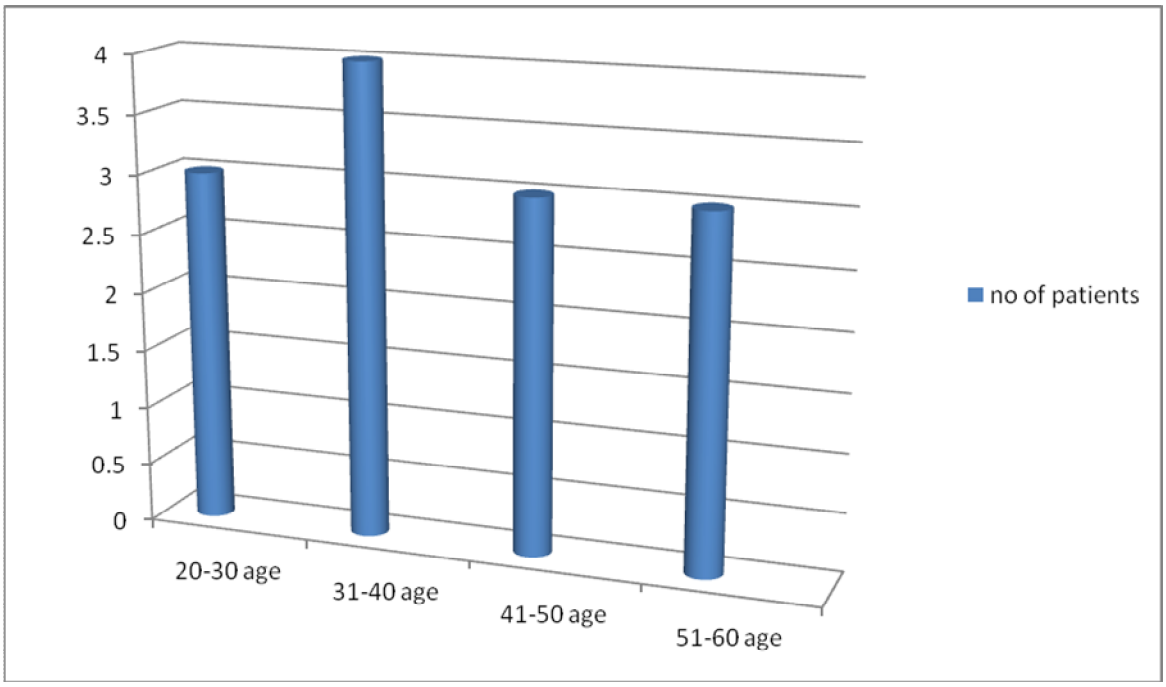
Success was defined as not requiring any urethral instrumentation. A satisfactory result was defined as the need for urethral manipulation once. Failure is defined as one who needs regular dilatation by urologist or revision urethroplasty or self-dilatation.

RESULTS AND DISCUSSION

RESULTS AND DISCUSSION

TABLE 1

AGEGROUP:

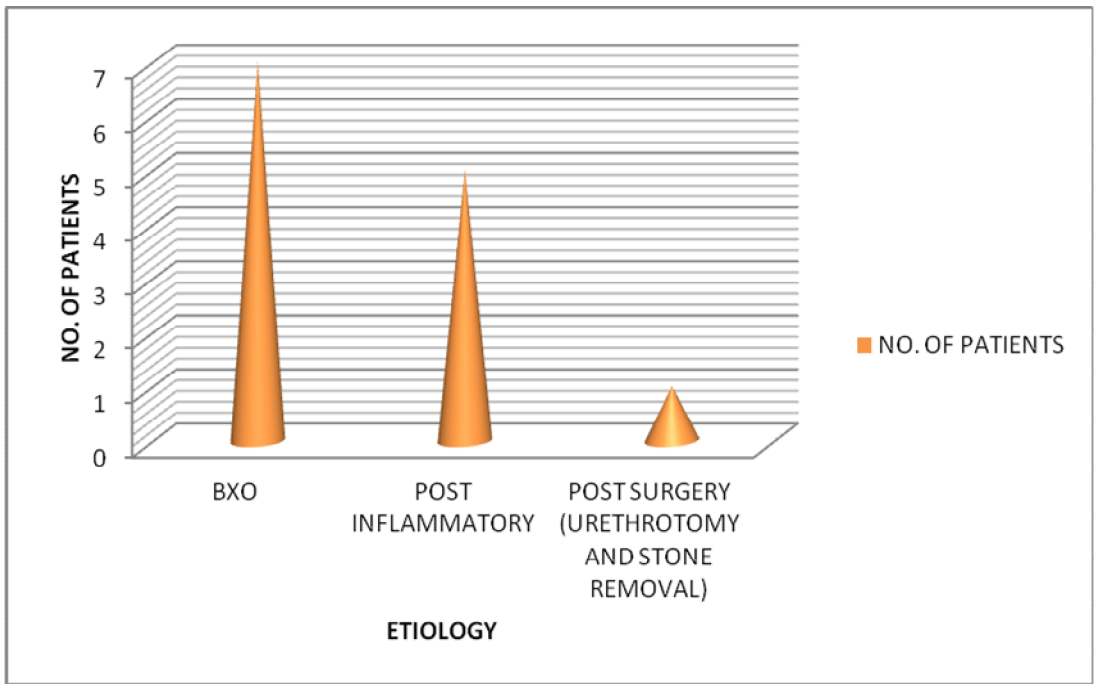


S.NO	AGE GROUP	NO OF PATIENTS
1	20-30	3
2	31-40	4
3	41-50	3
4	51-60	3

Total 13 patients were studied. The majority of patients presented between 31-40 years of age(total 4 patients). The age group of 51-60 patients was evaluated for comorbidity like HT, DM, and IHD.

TABLE 2

ETIOLOGY

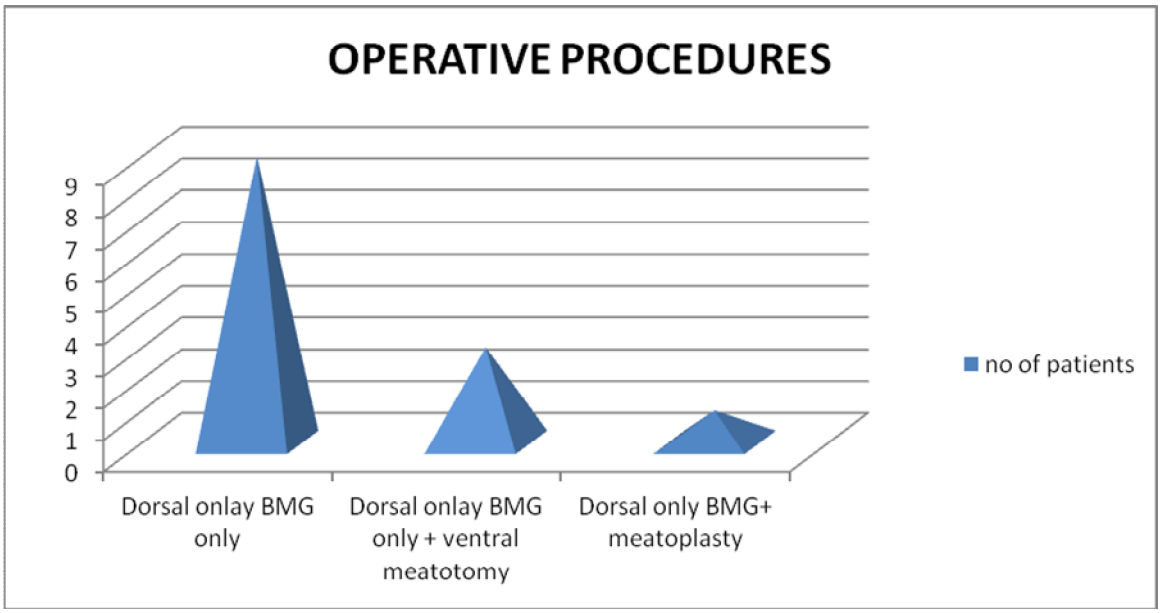


S.NO	ETIOLOGY	NO OF PATIENTS
1	BXO	7
2	Post inflammatory	5
3	Post Surgery (urethrotomy and stone retrieval)	1

According to etiology , BXO was the most common cause of the stricture (53.84%). The second most common cause was post inflammatory (38.46%). Next common was post-surgery (7.6%). This patient underwent urethrotomy and stone retrieval 7 months back.

TABLE 3

OPERATIVE PROCEDURES:

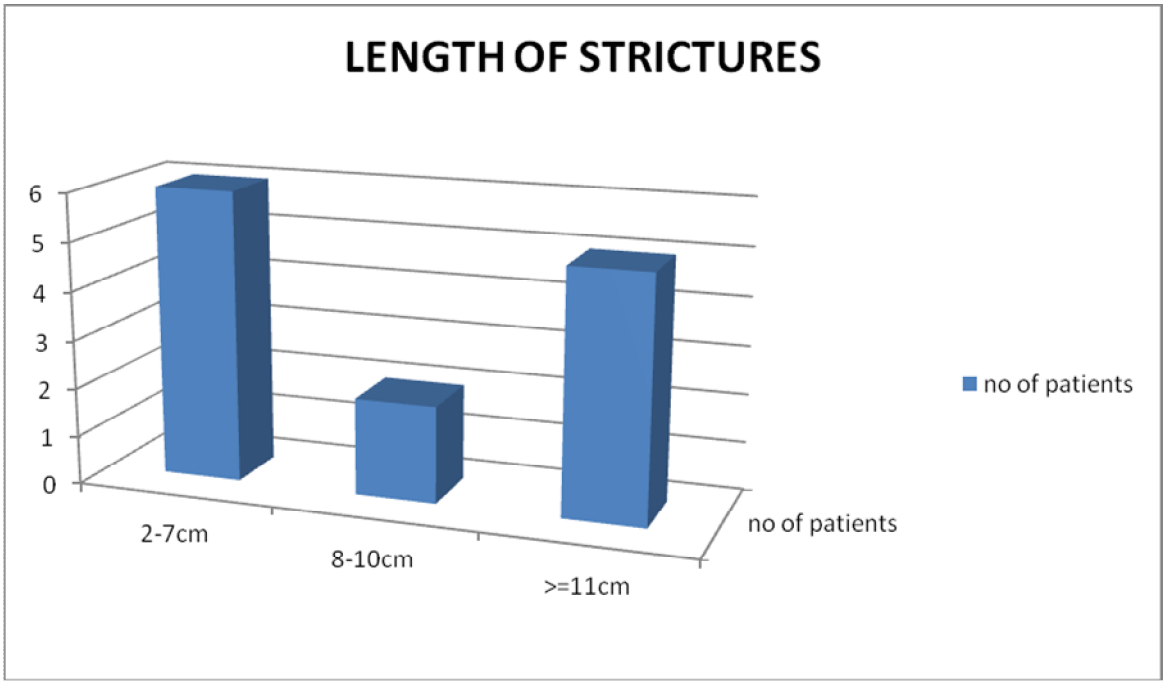


S.NO	OPERATIVE PROCEDURES	NO OF PATIENTS
1	Dorsal onlay BMG only	9
2	Dorsal onlay BMG + ventral meatotomy	3
3	Dorsal onlay BMG + meatoplasty	1

According to the procedure, the most commonly done was dorsal onlay buccal mucosal graft. Total number of patients was 9. Next was three cases of Dorsal onlay BMG + ventral meatotomy .All 3 cases were associated with BXO changes and meatal narrowing . One patient had pin hole meatus with BXO changes. So we did Dorsal onlay BMG + meatoplasty.

TABLE 4

LENGTH OF STRICTURES:

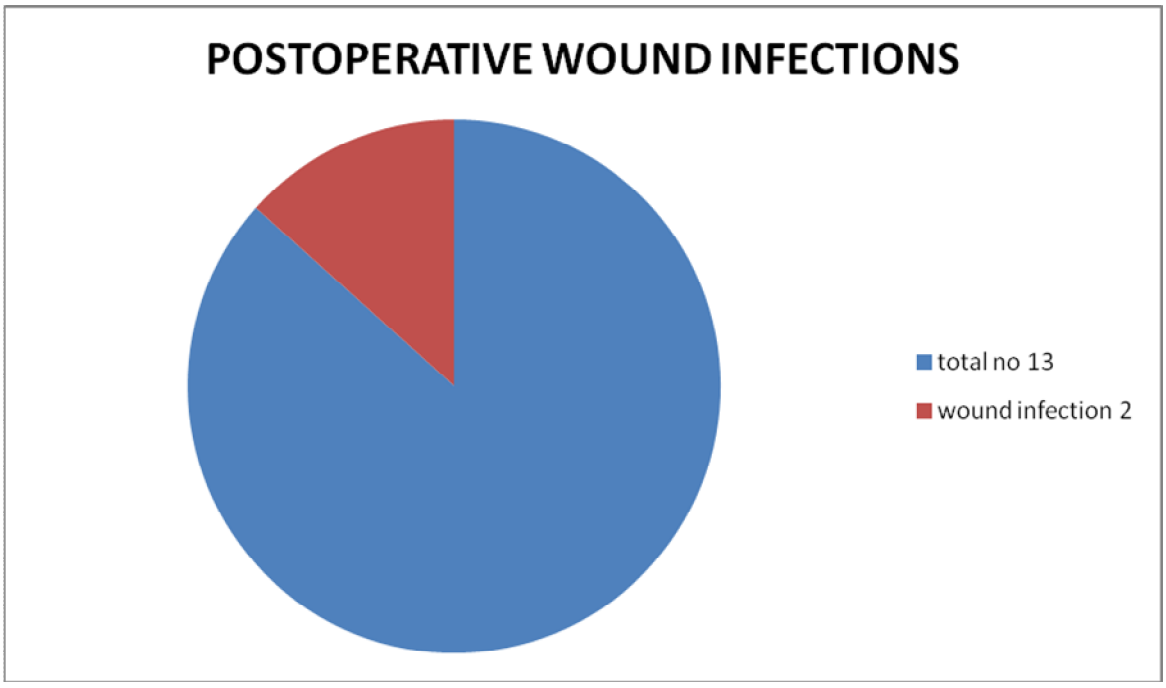


S.NO	LENGTH OF STRICTURE	NO OF PATIENTS
1	2-7cm	6
2	8-10cm	2
3	>=11cm	5

The most common group, belong to 2-7cm group (total no of patients 6).Next was 8-10cm group with only two patients. The next was the more than 11cm group, with a total of 5 patients. The length of the stricture was assessed on table and accordingly, graft length was chosen.

TABLE 5

POSTOPERATIVE WOUND INFECTIONS:

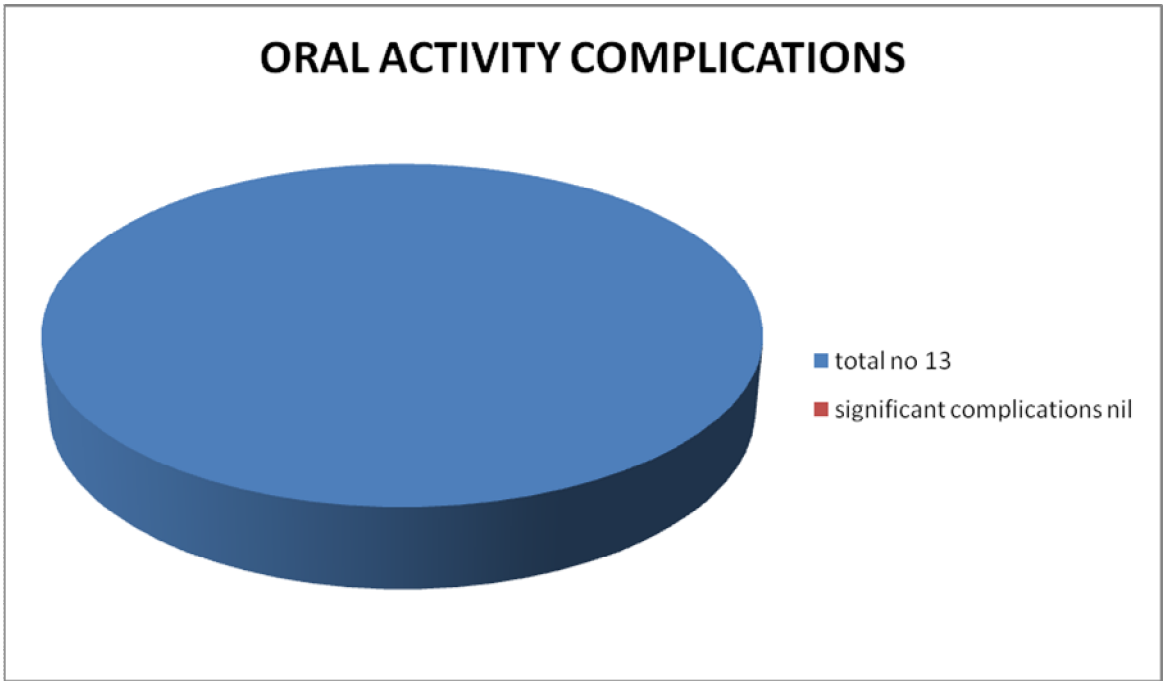


S.NO	TOTAL NO	WOUND INFECTION
1	13	2

Only two patients developed immediate post-operative wound infection .One patient developed 1cm penile skin necrosis at ventral aspect of penis. Another patient developed wound infection at suture site with development of a small sinus but no urinary leak. This patient had delayed catheter removal after six weeks. In both cases , wound infection settled. Peri catheter study was normal.

TABLE 6

ORAL CAVITY COMPLICATIONS:

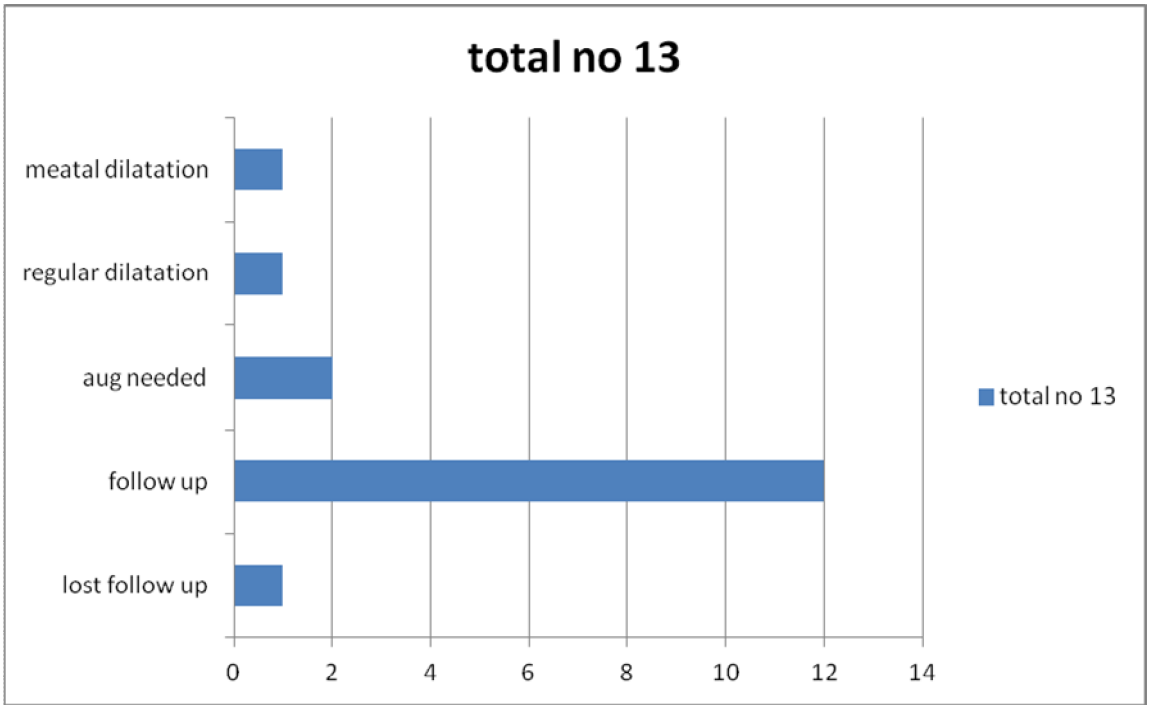


S.NO	TOTAL NO	SIGNIFICANT COMPLICATIONS
1	13	NIL

Of the 13 patients in the study, double cheek graft was taken from 3 patients. None of the patient developed significant complications.

TABLE 7

FOLLOW- UP AT 6 MONTHS:

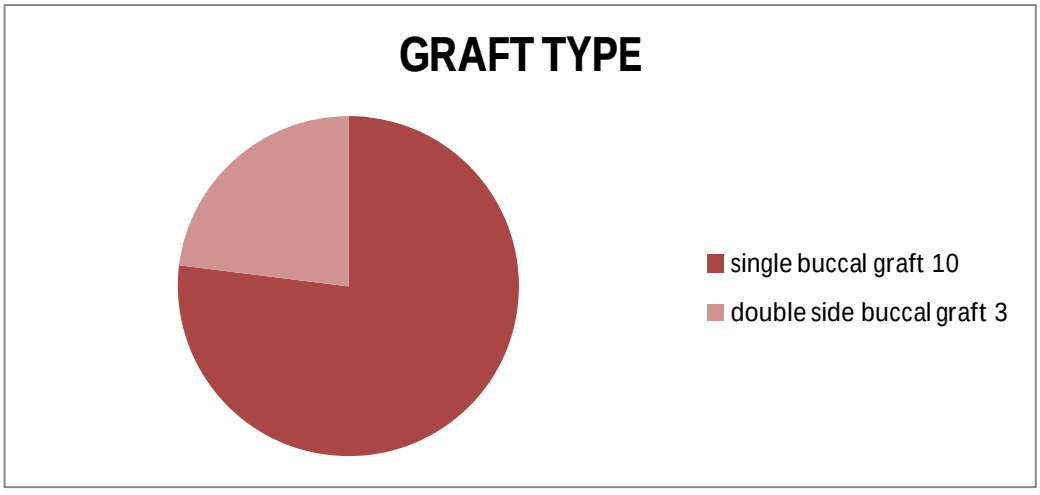


S.NO	TOTAL NO 13	
1	Lost follow up	1
2	Follow up	12
3	AUG needed	2
4	Regular dilatation	1
5	Meatal dilatation	1

One patient was lost follow up at six months. AUG was needed in 2 patients as they clinically had obstructive LUTS symptoms. In one patient uroflow showed obstructive pattern and in another patient uroflow was normal. In both, AUG was done. AUG was normal in one patient and in another AUG showed submeatal stenosis.

TABLE 8

GRAFT TYPE:



S.NO	GRAFT TYPE	TOTAL NO
1	Single buccal graft	10
2	Double side buccal graft	3

Post-operative follow up uroflow for less than 10cm

s.no		Peak flow	Average flow	Voided volume
1	Uro flow after catheter removal	28.8 ml/sec	19.75 ml/sec	278ml
2	At 3rd month follow up	21.5 ml/sec	15.25 ml/sec	287ml
3	On 6th month follow up	17.62 ml/sec	12.75 ml/sec	283ml

Post-operative follow up uroflow more than 10cm stricture repair

s.no	Follow up periods	Peak flow	Average flow	Voided volume
1	Uro flow after catheter removal	23.8 ml/sec	15.6 ml/sec	278ml
2	At 3rd month follow up	18.2 ml/sec	13.8 ml/sec	235ml
3	On 6th month follow up	17.75 ml/sec	15.5 ml/sec	288ml

Comparison study of past urethral stricture

Variables	Anant kumar et al	Ducket et al	Our study
No of patients	25	2	7
Meatal peno bulbar stricture	4	2	2
Pan urethral stricture	21	0	4
Failure	3	1	2
Follow up months	3-52	6-84	3-6 months

Our study was compared with the study by Anant kumar and Ducket. Pan urethral stricture was seen in 4 and stricture of the bulbar urethra in 2. Failure was noted only in 2 cases at a follow up of 3-6 months. Further follow up is required in our study, to better delineate the outcome.

Comparison study of medium bulbar stricture

Variables	Vito et al	Christoper et al	Our study
No of patients	23	25	6
Success	23	24	6
Failure	0	1	0
Follow up months	3-50	41-100	3-6 months

Compared with Vito et al and christoper et al our series had lesser number of patients and fewer months of follow up.

SALIENT FUTURES:

1. Anterior urethral stricture occurs most commonly in the age group of 30-40 years old.

2. Balanitis xerotica obliterans is the commonest cause of stricture urethra.

3. Meatal narrowing was present in 30.76% of the cases

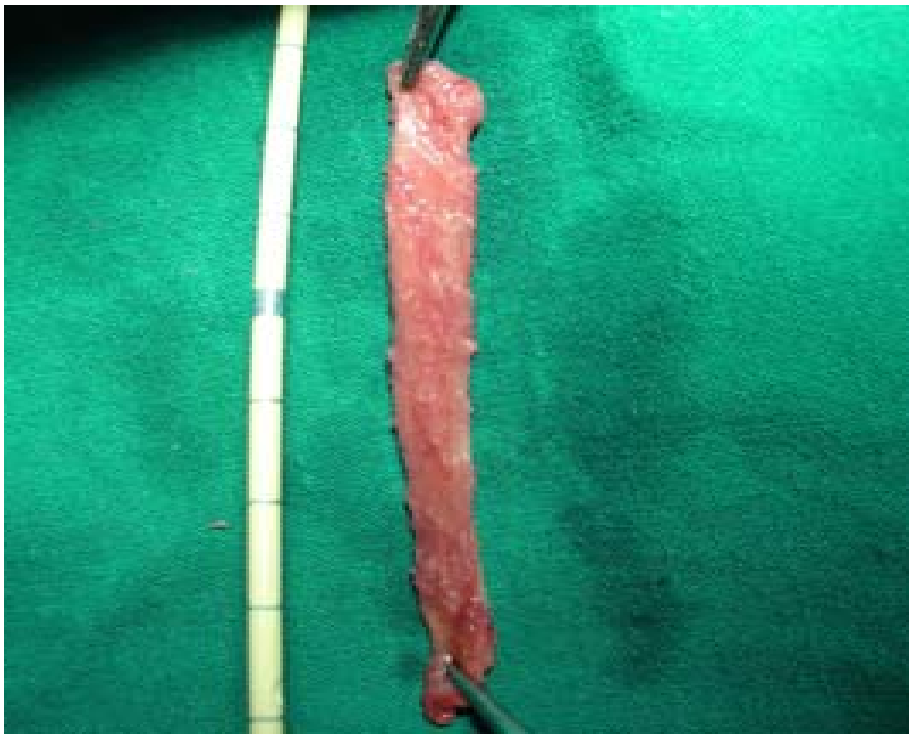
4. Buccal mucosal donor site heals with minimum complication

5. Total 13 grafts was used ;no graft loss has occurred.

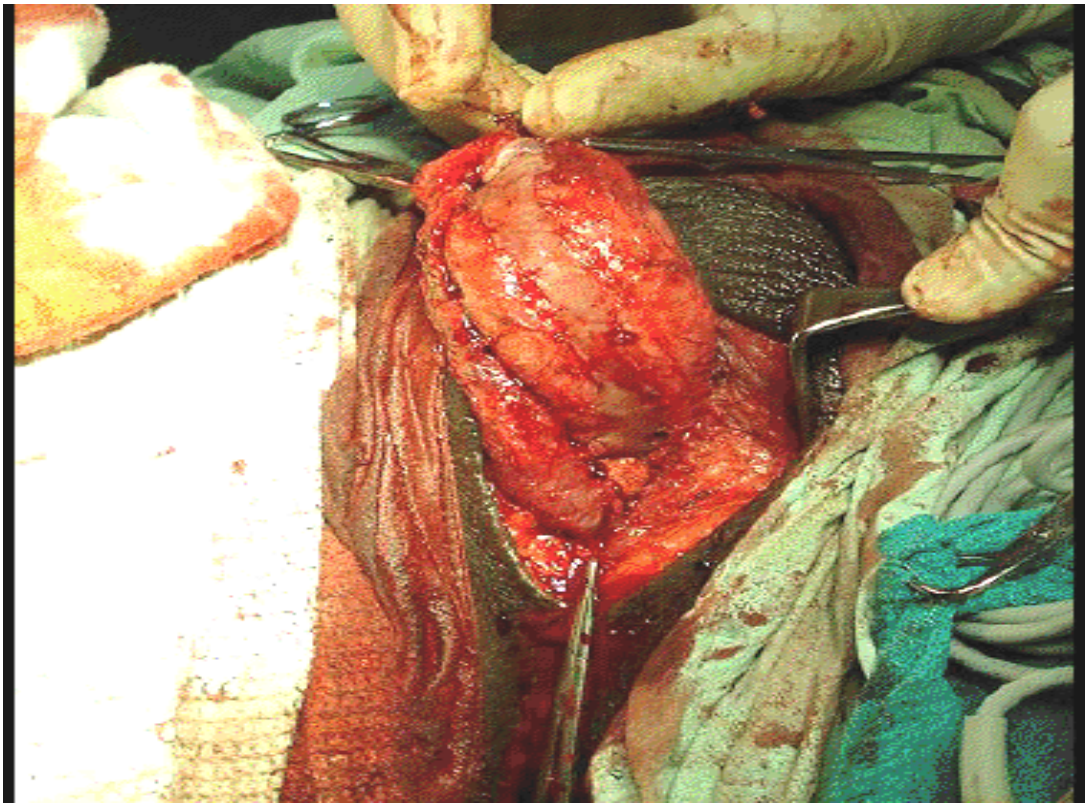
6. Medium length stricture had 100% results.

PICTURES SHOWS MARKING OF BUCCAL MUCOSA GRAFT

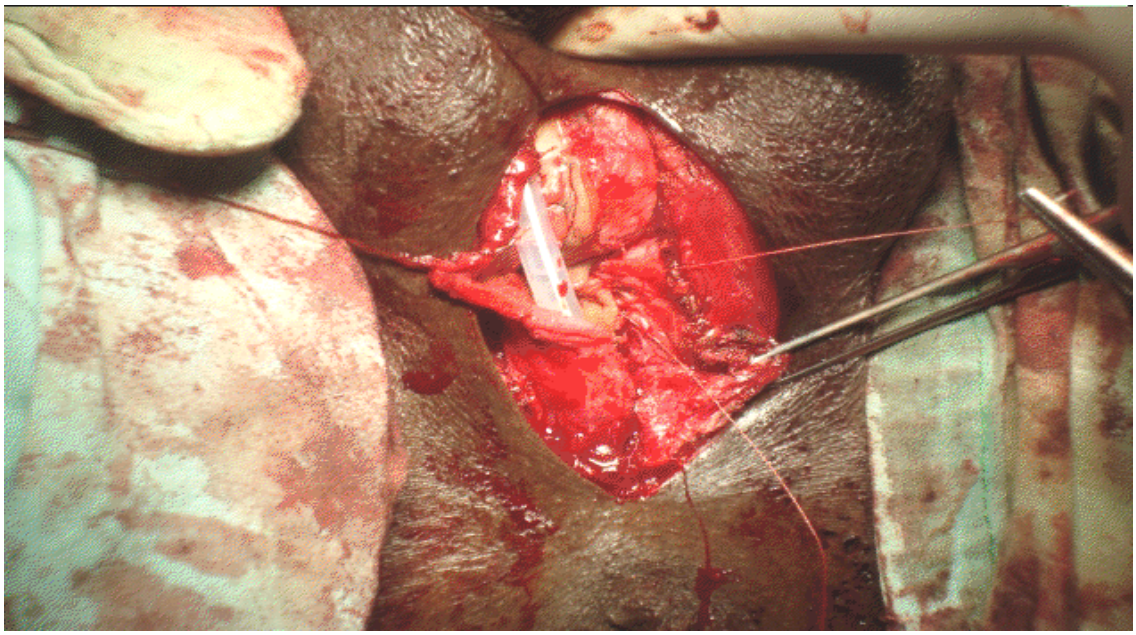
PICTURES SHOWS AFTER HARVESTING BUCCAL MUCOSA GRAFT



THE GRAFT IS SUTURED OVER THE CORPORAL BED



THE LEFT MUCOSAL MARGIN OF THE OPENED DISTAL URETHRA IS SUTURED TO THE LEFT SIDE OF THE PATCH GRAFT



CONCLUSION

1. Dorsal onlay is the preferred form of graft placement

2. Buccal mucosal graft is the ideal substitute for urethra, especially in medium length urethral stricture

3. Buccal mucosa graft has good graft properties for graft survival.

4. Oral cavity donor site had no significant complications.

5. Failure rate was 15.38%, so dorsal on lay buccal mucosal urethroplasty is ideal for urethral strictures.

6. Longer follow up is need (keeping attrition over a period of time for substitution urethroplasty in mind before coming to definite conclusion).

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PROFORMA FOR THE STUDY

NAME; AGE; SEX; IPNO;

ADDRESS: PHONE NO:

DATE OF ADMISSION: DATE OF DISCHARGE:

PRESENTING SYMPTOMS: DURATION:

1. H/O poor stream urine.
2. H/O intermittency.
3. H/O straining to void.
4. H/O Post void dribbling.
5. H/O incomplete emptying.
6. H/O recurrent urethritis.
7. H/O prolonged catheterization.
8. H/O trauma.

COMORBID CONDITITONS: DM/HT/IHD/TB

PAST HISTORY:

H/O previous urethral surgery.

H/O urethral dilatation.

PERSONAL HISTORY:

1. Smoker.

2. Alcoholic.

3. Exposure to csw.

CLINICAL EXAMINATION:

INVESTIGATIONS:

1. Urine routine.

2. Urine c&s.

3. Hb.

4. Renal parameters.

5. Uroflow.

6. Ascending urethrogram.

7. Cystoscopy.

OPERATIVE FINDINGS:

POSTOPERATIVE PERIOD:

POSTOPERATIVE PERIOD COMPLICATIONS:

FOLLOW UPAT 3RD MONTH:

1. Uroflow.
2. Ascending urethrogram.(if needed).

FOLLOW UP AT 6th MONTH:

1. Uroflow.
2. Ascending urethrogram. (if needed).

PATIENT FEED BACK:

UROFLOWMETRY											
S. NO	**PATIENT NAME/ procedure**	**AGE**	**IP NO**	**LENGTH OF STRICTURE**	**CAUSE**	**PARAMETERS**	**PREOP**	**IMMEDIATE CATHETER REMOVAL**	**3 MONTHS**	**6 MONTHS**	**AUG IF NECESSARY**
1	Ravichandran, dorsal onlay till meatas	34	10474	6cm	BXO	Peak flow rate, avg flow rate,Voided volume	SPC	29ml/sec,18ml/sec,320ml	21ml/sec, 16ml/sec,300ml	18ml/sec,12ml/sec,300ml	not necessary
2	Varadharaj, dorsal onlay	59	14485	5cm	BXO	Peak flow rate, avg flow rate,Voided volume	2ml, 1.5ml/sec, 150ml	26ml/sec,18ml/sec,240ml	20ml/sec,16ml/sec,240ml	19ml/sec,12ml/sec,300ml	not necessary
3	Balaji, dorsal onlay	20	37000	4cm	Post inflammatory	Peak flow rate, avg flow rate,Voided volume	7ml/sec, 5ml/sec, 175ml	25ml/sec,20ml/sec,300ml	23ml/sec,16ml/sec,270ml	19ml/sec,16ml/sec,250ml	not necessary
4	Basha, dorsal onlay meatatomy	40	39024	11cm	BXO	Peak flow rate, avg flow rate,Voided volume	spc	16ml/sec,12ml/sec,200ml	17ml/sec,15ml/sec,220ml	lost follow up	not necessary
5	Thulukanam, dorsal onlay urethroplasty	38	3821	13cm	Post inflammatory	Peak flow rate, avg flow rate,Voided volume	6ml/sec, 4ml/sec, 150ml	22ml/sec,16ml/sec,200ml	19ml/sec,14ml/sec,215ml	16ml/sec,13ml/sec,180	not necessary
6	Tamilarasan, dorsal onlay flap meatoplasty	52	1773	13cm	BXO	Peak flow rate, avg flow rate,Voided volume	spc	24ml/sec,19ml/sec,300ml	15ml/sec,12ml/sec,175ml	20ml/sec,15ml/sec,325	not necessary
7	Sivalingam, dorsal onlay	65	38597	10cm	BXO	Peak flow rate, avg flow rate,Voided volume	15ml/sec, 3ml/sec, 145ml	30ml/sec,21ml/sec,270ml wound gaping	19ml/sec,12ml/sec,300ml	18ml/sec,12ml/sec,210	not necessary

8	Venkatesan, dorsal onlay + ventral meatetomy	21	44573	11cm	BXO	Peak flow rate, avg flow rate,Voided volume	spc	22ml/sec,11ml/sec,300ml	15ml/sec,10ml/sec,290ml	13ml/sec,10ml/sec,375	submeatal-on regular dilation
9	Chan basha, dorsal onlay urethroplasty	26	39219	6cm	Post inflammatory	Peak flow rate, avg flow rate,Voided volume	spc	28ml/sec,15ml/sec,255ml	26ml/sec,17ml/sec,300ml	20ml/sec,13ml/sec,390	not necessary
10	Arumugam, dorsal onlay urethroplasty	47	43914	10cm	post surgery (open ventral urethrotomy &stone removal)	Peak flow rate, avg flow rate,Voided volume	spc	28ml/sec,16ml/sec,250ml	18ml/sec,12ml/sec,190ml	12ml/sec,10ml/sec,160ml	normal steady regular dilation
11	Abubakar, dorsal onlay urethroplasty	34	45518	5cm	Post inflammatory	Peak flow rate, avg flow rate,Voided volume	7ml/sec,2ml/sec,100ml	30ml/sec,22ml/sec,290ml	25ml/sec,18ml/sec,300ml	20ml/sec,15ml/sec,310ml	not necessary
12	Rajendran, dorsal onlay urethroplasty	42	8194	7cm	Post inflammatory	Peak flow rate, avg flow rate,Voided volume	SPC	35ml/sec,20ml/sec,300ml	20ml/sec,15ml/sec,400ml	15ml/sec,12ml/sec,350ml	not necessary
13	Ponnusamy, dorsal onlay and ventral meatatomy	50	17930	13cm	BXO	Peak flow rate, avg flow rate,Voided volume	3ml/sec, 2ml/sec, 110ml	35ml/sec,20ml/sec,250ml	25ml/sec,18ml/sec,275ml	22ml/sec,16ml/sec,300ml	not necessary

	FOLLOW UP DETAILS										
						UROFLOWMETRY					
S.NO	PATIENT NAME	AGE	IP NO	LENGTH OF STRICTURE	CAUSE	PARAMETERS	PREOP	IMMEDIATE CATHETER REMOVAL	3 MONTHS	6 MONTHS	AUG IF NECESSARY
1	Ravichandran	34	10474	6cm	BXO	Peak flow rate, avg flow rate,Voided volume	SPC	29ml/sec,18ml/sec,320ml	21ml/sec, 16ml/sec,300ml	18ml/sec,12ml/sec,300ml	not necessary
2	Varadharaj	59	14485	5cm	BXO	Peak flow rate, avg flow rate,Voided volume	2ml, 1.5ml/sec, 150ml	26ml/sec,18ml/sec,240ml	20ml/sec,16ml/sec,240ml	19ml/sec,12ml/sec,300ml	not necessary
3	Balaji	20	37000	4cm	Post inflammatory	Peak flow rate, avg flow rate,Voided volume	7ml/sec, 5ml/sec, 175ml	25ml/sec,20ml/sec,300ml	23ml/sec,16ml/sec,270ml	19ml/sec,16ml/sec,250ml	not necessary
4	Basha	40	39024	11cm	BXO	Peak flow rate, avg flow rate,Voided volume	spc	16ml/sec,12ml/sec,200ml	17ml/sec,15ml/sec,220ml	lost follow up	not necessary
5	Thulukanam	38	3821	13cm	Post inflammatory	Peak flow rate, avg flow rate,Voided volume	6ml/sec, 4ml/sec, 150ml	22ml/sec,16ml/sec,200ml	19ml/sec,14ml/sec,215ml	16ml/sec,13ml/sec,180ml	not necessary
6	Tamilarasan	52	1773	13cm	BXO	Peak flow rate, avg flow rate,Voided volume	spc	24ml/sec,19ml/sec,300ml	15ml/sec,12ml/sec,175ml	20ml/sec,15ml/sec,325ml	not necessary

7	Sivalingam	65	38597	10cm	BXO	Peak flow rate, avg flow rate,Voided volume	15ml/sec, 3ml/sec, 145ml	30ml/sec,21ml/sec,270ml wound gaping	19ml/sec,12ml/sec,300ml	18ml/sec,12ml/sec,210ml	not necessary
8	Venkatesan	21	44573	11cm	BXO	Peak flow rate, avg flow rate,Voided volume	spc	22ml/sec,11ml/sec,300ml	15ml/sec,10ml/sec,290ml	13ml/sec,10ml/sec,375ml	not necessary
9	Chan basha	26	39219	6cm	Post inflammatory	Peak flow rate, avg flow rate,Voided volume	spc	28ml/sec,15ml/sec,255ml	26ml/sec,17ml/sec,300ml	20ml/sec,13ml/sec,390ml	not necessary
10	Arumugam	47	43914	10cm	post surgery (urethrotomy done for stone removal)	Peak flow rate, avg flow rate,Voided volume	spc	28ml/sec,16ml/sec,250ml	18ml/sec,12ml/sec,190ml	12ml/sec,10ml/sec,160ml	normal steady regular dilation
11	Abubakar	34	45518	5cm	Post inflammatory	Peak flow rate, avg flow rate,Voided volume	7ml/sec,2ml/sec,100ml	30ml/sec,22ml/sec,290ml	25ml/sec,18ml/sec,300ml	20ml/sec,15ml/sec,310ml	not necessary
12	Rajendran	42	8194	7cm	Post inflammatory	Peak flow rate, avg flow rate,Voided volume	SPC	35ml/sec,20ml/sec,300ml	20ml/sec,15ml/sec,400ml	15ml/sec,12ml/sec,350ml	not necessary
13	Ponnusamy	50	17930	13cm	BXO	Peak flow rate, avg flow rate,Voided volume	3ml/sec, 2ml/sec, 110ml	35ml/sec,20ml/sec,250ml	25ml/sec,18ml/sec,275ml	22ml/sec,16ml/sec,300ml	not necessary