Dept. of Surgery,
Fac. Vet. Med., Assiut University,
Head of Dept. Prof. Dr. M.T. Nassef.

SUBSTITUTION URETHROPLASTY USING A VENOUS GRAFT: EXPERIMENTAL TRIAL IN DONKEY

(With 16 Figures)

By

F.M. MAKADY; M. E. OSMAN*; A.M. ABOU-ZIED*; I.H. AHMED and A.I. AHMED*

(Received at 21/5/1992)

إستعاضة قطعة من القناة البولية (الأحليل الذكـــــــري)
برقعة وريدية : محاولة تجريبية في الحمير

فتحي مكـــادي ، محمد عصام الدين ، عبد المنعم أبو زيـــــــد
إبراهيم حسين ، عبد الفتاح إبراهيم

عملية إستعاضة قطعة من القناة البولية (الأحليل الذكري) برقعة من الأوردة أجريـــت في ٩ حمير · في كل حمار أستئصلت قطعة من الأحليل الذكري وأخرى من الوريد الودجـــي أو الوريد الصافن · في ثلاثة حمير أستخدمت أنبوبة رايل مثقبة وذلك لغرضين أولهمـــا : تصريف البول من المثانة وثانيهما : لتعمل كسقالة للأنستيموز · تم عمل الأنستيموز الملوقـــي بين قطعة الوريد وقناة البول بتقريب نهايتهما من بعض ثم خياطتهما بإستخدام التقطيـــب المتقطع · في ٦ حمير تم عمل فتحة في المبال في منطقة العجان ثم أدخلت نها قـــطـــرة فولي وذلك لتصريف المثانة كذلك أدخلت أنبوبة أخرى لتعمل كسقالة للأنستيموز ملوقي الشكل · وضعت الحيوانات تحت الرعاية الطبية والملاحظة لمدة ثلاثة أشهر تم خلالها تسجيل النتائـج · أوضحت النتائج وجود ناسور بولي في حمار واحد كذلك وجود ضيق في المجرى البولي فـــي حمارين ومجرى بولي مفتوح (بدون ضيق) أملس في باقي الحيوانات · دلت النتائـــج على أن عملية إستعاضة مجرى البول برقعة من الوريد تعتبر محاولة قيمة يمكن بها علاج عيـون مجرى البول التي يتراوح طولها من ٥ر٢ إلى ٥ سم على أن يكون الأنستيموز تم عمله بدقـــة بإستخدام القطب المستمرة ويكون تصريف البول عن طريق تحويله بأعلى مكان الأنستيموز ·

SUMMARY

Substitution urethroplasty was performed in 9 donkeys. In each donkey a urethral segment was removed and a venous graft from the jugular or saphenous vein was exposed and harvested by ligation of both ends of the vein. In three animals (group I), a suitable sized multifenstrated Ryle tube was introduced to bypass the urethra and the venous graft to drain the urinary bladder. The cut ends of the urethra and those of the graft were approximated and spatulated anastomosis was performed on the tube using simple interrupted suture. In six donkeys (group II) a perineal urethrotomy was done and Foley's catheter was introduced through it to drain the bladder and the anastomosis was separately stented.

*: Dept. of Urology, Faculty of Medicine, Assiut University.

The animals were observed for 3 months and the outcome and complications were recorded. After follow up for 3 months, one animal had a fistula, 2 animals had urethral stricture and the rest of the animals (6 donkeys) had smooth patent pathway. The results indicated that venous graft is a worthy trial for substitution of urethral defects of variable lengths (2-5cm long). The anastomosis should be spatulated and stented with proximal urinary diversion.

INTRODUCTION

Substitution urethroplasty means using a graft for correction of various forms of urethral defects (TURNER-WARWICK, 1990). He stated that no substitute for the urethra is as good as the urethra itself. Some substitutes are much better than others; but all have inherent short comings. Dry skin grafts (scrotum, ear, arm, thigh etc.), penile skin graft and some wet epithelial surfaces (buccal, vaginal, libial, preputial and bladder) have been used as urethral grafts with moderate success in humans (TURNER-WARWICK, 1983; HENDREN et al., 1986; TURNER-WARWICK, 1989; EL-KASABY et al., 1991 and VALLA et al., 1991). In the available literatures, there are no reports of substitution urethroplasty using venous grafts.

The present challenge is to reduce- to a minimum- the incidence of complications associated with substitution procedures, many of which are related to the characteristics of the substitute itself (TURNER-WARKWICK, 1989). Urologists are still looking forward for an alternative suitable urethral substitute.

The aim of the present work is to evaluate the efficacy of the venous graft for urethral substitution in donkeys.

MATERIAL and METHODS

Nine healthy young (12-14 months) male donkeys weighing 90-130 Kg were used. Feeding was withheld 12 hours before surgery. Procaine penicillin G (22.000 IU/Kg. intramuscularly "IM" and gentamicin "3.3 mg/Kg IM) were administered 1 hour before and 12 hours after surgery. All donkeys were premedicated withf combelen (0.2 mg/Kg intravenously "IV"). The donkeys were positioned in lateral recumbency. To expose the operative field, the front feet are secured by one rope and the left hind leg (uppermost) flexed upward and pulled forward with a second rope. In all donkeys the surgical procedure was performed under the effect of chloral bydrate narcosis in combination with thiopental sodium.

Hemostasis was initially maintained by elastic tourniquet, tightly wrapped and tied in a square knot around the penile shaft at the penil-scrotal junction.

The catheterized and tourniquetted penis was pulled into extension by holding the glans. With the penis stabilized in one hand, a three-sided rectangular skin incision was made on the ventral surface of the middle portion of the penis (Fig. 1). The dimentions of the rectangular skin incision were determined according to the limits

of the desired urethral exposure. The skin and subcutaneous tissue were divided and reflected. The dissection extended deeply and longitudinally exactly on the midline through the bulbospongiosus muscle to expose the urethra. The muscles around the urethra were perserved for covering the graft. The urethral segment was freed from its tissue bed with alternating blunt and sharp careful scissor dissection. When this was completed (Fig. 2), the tourniquet was loosened and bleeders identified and ligated.

To remove the urethral segment, the urethra was dissected all around and the desired segment was then removed (Fig. 3). The cut urethral ends were demarcated by 4-0 catgut suture (Fig. 4).

A thigh skin incision (group I) or neck skin incision (group II) was made directly over the saphenous (3 animals) or jugular veins (6 animals). A venous segment of variable lengths (3.5-6 cm) was exposed (Fig. 5) and harvested with ligation of both ends of the vein or any of its tributaries (Fig. 6). Venous valves are then ablated and the graft was immersed in normal saline solution.

The catheter was then introduced through the external meatus then passed through the venous graft and again through the proximal cut end of the urethra. The cut ends of the urethra and those of the graft were approximated and an spatulated end to end anastomosis was performed (Fig. 7, A&B) using 4-0 chromic sutures in an interrupted pattern in group I and in a locked continuous pattern in group II. The spongiosus muscle was then approximated over the graft. Then the subcutaneous tissue was overlapped and sutured over the repair. The skin flap was closed and routine closure of the thigh and neck incisions were performed. In 3 animals, a suitable sized multifenstrated Ryle tube, then introduced to bypass the urethra and the graft to drain urinary bladder. In 6 donkeys (group II) the urethral catheter was used only as a stent for the anastomosis and bladder drainage by Fole's catheter introduced through a perineal urethrotomy. Preineal urethrotomy was performed as described by HOLT and PEARSON, 1984.

Tetanus antitoxine was given at the time of surgery. The animals were maintained on prophylactic antibiotics for 5 days postoperatively. The animals were carefully followed and observed for urine drainage, urine leakage, obstrcution of the catheter and the presence of edema, cellulitis, penile swelling or infection. After removal of the catheter the animals were observed for the pattern of urination, urethral discharge or leakage.

Ascending urethrogram had been performed before the operation as a control (Fig. 8) and 2 months after the operation. By the third month 3 donkeys with satisfactory urine flow were euthanatized with barbiturate overdose. The urethra was exposed the site of the anastomosis was examined for its patency. The urethra was isolated and opened longitudinally and examined for any luminal narrowing and for creaping and spreading of the mucosal epithelium along the venous grafts. Sections of the grafts were examined histologically.

RESULTS

Donar site of the graft:

In group I (3 animals) the saphenous vein graft created minimal difficulties in anastomosis because of the discrepency in size and the presence of valves. In group II (6 animals) the jugular vein, on the other hand is valveless and wide to provide a more suitable anastomosis.

Graft length:

Graft length	group I	group II
3.5 cm	2	1
4.5	1	2
6.0 cm	0	3

To test for ideal length of the urethra that can be substituted, different lengths of the graft had been chosen. No problems were noticed using grafts of 3.5-4.5 cm long. A temporary urimary fistula had been recorded in one animal with a graft 6.0 cm long.

Type of urinary shunt:

Type of shunt	Period of drainage	No. of animals
Urethral catheter drainage	4 - 7 days	3 (group I)
Perineal urethrotomy + urethral stenting	10-15 days	6 (group II)

In 2 donkeys of group I mucous plugs and incrustations partialy obstructed the tube, which necessitated its removal on the 4th to 7th postoperative day. In those animals marked penile edema and urinary leakage that persisted in one animal had been noticed.

In group II (6 animals), a perineal urethrotomy was done and a large sized Foley's catheter (22-24 ch) was introduced through it to drain the bladder. The anastomosis was stented (separately) for 10-15 days. After removal of the stent and Foley's catheter a mild penile edema with minimal urethral discharge was noticed in only one animal. In group II animals a free unobstructed urine flow was noticed and the urethrotomy wound healed spontaneously.

Assending urethrography:

Ascending urethrography done two months after operation revealed a smooth patent pathway in 6 animals (Fig. 9 A&B).

Postoperative complictions:

A) Early compliations (1st week):

Complication	group I	group II
Penile edema	2 animals	1
Wound sepsis (superficial	1 animal	-
Obstruction of the stent	2	-
Urinary leakage	2	-

B) Delayed complications (1 week after stent removal):

	Group I	Group II
Temporary urinary leakage	2	1
Sputtering fof the stream	1	1

C) Late complications (confirmed by ascending urethrogram):

	Group I	Group II
Urethral fistula	1	-
Urethral striccture	1	1

In group I: Penile edema had resolved in one animals after good care and antibiotic therapy and persisted in the other animal. Temporary urinary leakage had been noticed in 2 animals which stoped in one and persisted in the other (Fig. 10). Ascending urethrogram reaveled a urethral strecture in this animal (Fig. 11).

In group II: Penile edema and uretheral discharge resolved spontaneosly after stent removal. Although ascending urethrography revealed a relative narrowing in the proxemal site of the anastomosis (Fig. 9 B) all animals of this group exahibited a satisfectory voiding.

Autopsy findings:

On postmortem examination, the grafts were successfully taken, thickened, patent and nonredundant with insignificant narrowing at the site of anastomosis. The urothelium was covering nearly the whole extent of the grafts except a few millimeters in their center.

Histologic examination:

Histologic examination of cut sections of the grafts revealed that the endothelium had been nearly replaced by a transitional or pseudostratified squamous epithelium (Fig. 12-16).

DISCUSSION

The present challenage in any substitution urethroplasty, is to reduce to a minimum the incidence of complications associated with these procedures. Many of these complications are related to the characteristics of the substitute itself (TURNER-WARWICK, 1989). Dry skin grafts or flaps (scrotum, ear, arm, thigh, ect..) develop a potentially severe eczemateous reaction when exposed to urine. Hairiness, the thick dermis and subcutaneous fat are other factors that add to the potential complications. The penile skin is both virtually hairless and considerabley moisture resistant. It is

a relatively satisfactory and reliable urethral substitute, but sometimes this preputial or penile skin is deficient or scarred, particularily in recurrent or complicated urethroplasties. In addition, these tubal grafts may undergo retraction or outpouching if a distal obstruction develops in the urinary passage (WARWICK, 1983).

Bladder mucosal grafts have been utilised for urethral substitution, but the problems of mucosal weaping and relatively high fistulization rate have limited its utilization to recurrent and difficult cases with deficient or scarred penile skin (HENDREN et al., 1986 and VALLA et al., 1991). The buccal mucosa has been utilised as a graft for partial urethral substitution by EL-KASABY et al. (1991) and yielded promising results, but it was restricted to short urethral defects (1-2 cm long).

Nevertheless urologists are still looking forward for a suitable urethral substitute that has the least possible complication and provides a satisfactory anatomical and functional outcome. In the present study, why should not we try to test for the efficacy of venous graft as a urethral substitute?. In addition to its tubular structure the venous endothelial lining can resist infection and the elastic content of the venous wall provides adequate destinsibility for urinary stream.

Regarding the doner site of the graft, it is clear that the jugular vein is a good choice for a better urethral substitute because of its large calibre and abscence of values. This provides a better chance for end to end spatulated anastomosis and obviated the need for valve ablation (a necessary step in the saphenous vein graft).

A continuous suture spatulated anastomosis had been done which is apperently in contradistinction to the traditional beleif that an interrupted type of suturing is better in a mucosa to mucosa end anastomosis, than a continuous type of suture. An interrupted suture is less traumatic less ischaemic but here the situation is different because of the difference in structure between the urethra and the endothelium of the vein where a meticulous good coaptation of both ends with a water tight anastomosis is mandatory for the urothelium to bridge the suture line. A musculo-adventitial continuous locked suture that saves the urothelium to bridge more rapidly seams to be the best way that should be applied as suggested by BOJRAB, 1983.

In the present trial no sharp figures could be announced as regards the ideal length of the venous graft that could substitute for a urethral defect. But a 6 cm venous graft gave less satisfactory results (a stricture at the proximal side of anastmosis had developed in one animal and a sputered stream was noticed in another one in group II animals). This may be due to the fact that the vascular wall derives its nutritional and metabolic requirements from the vasa vasora and from the circulating blood through its lumen (both are interrupted in case of a venous graft urethral substitution). No problems were encountered with grafts of 3.5-4.5 cm length. The graft should be 0.5-1 cm longer than the urethral defect that should be bridged to allow for the contracture that usually occurs in vascular grafts. Also this allows a tension free anastomosis specially when erection may occur and endanger the whole graft outcome.

As regards the urinary shunts applied in these animals, the worst results were obtained with urethral catheter drainage as the sole shunt applied. The mucous and encrustations blocked the tube leading to urination around the stent with leaking from the wound and penile edema. In animals where perineal urethrotomy was done, a smooth postoperative outcome was noticed and the urethrotomy wound spontenosly closed 7-10 days after stent removal. PIKE et al. (1991) concluded that the use of urethral stent for urinary drainage was associated with shorter postoperative hospitalisation and minimal short-term complications. This marked contradiction could be attributed to the difference in the constituents between human and animal urine which lead to early obstruction of the stent with subsequent premature removal.

The postoperative complications encountered dont differ from the usual complications encountered after any urethroplasty.

In conclusion a venous graft is a worthy trial for substitution of urethral defects of variable lengths (2.5-5 cm long). It is tubular of an elastic wall that should allow for distensibility and variation in length of the urethera that happens with alternating tumescence and detumescence and it had been confirmed by histopathology that venous grafts act as scafold for the urothelium to creep and cover it. The anastomosis should be spactulated with musculo adventitial continuous suturing. The anastomosis should be stented for 10-15 days with proximal urinary diversion.

REFERENCES

Bojrab, J.M. (1983): Current techniques in small animal surgery. 2nd ed. Lea and Fibiger philadelphia. 315-317.

El-Kasaby, W.A.; Noweir, M.A.; Fathalla, M.; El-Halaby, P.M.; Zakaria and ElBeialy, H.M. (1991): The use of buccal mucosal patch graft in the management of anterior urethral strictures. Kas-ElEini Journal Medicine. 22: 305-311.

Hendren, W.H. and Reda, E.F. (1986): Bladder mucosa graft for reconstruction of male urethra. J. Pediatr. Sug. 21: 189-192.

Holt, P.E. and Pearson, H. (1984): Urolithiasis in the horse a review of 13 cases. Equine Vet. J. 16: 31-34.

Laverty, S.; Pascoe, R.J.; Ling, V.G.; Lavoie, P.J. and Ruby, L.A. (1992): Urolithiasis in 68 horses. Vet. Surg. 21, 1: 56-62.

Pike, J.G.; Brzezinski, A. and Kiruluta, G.H. (1991): Use of a urethral splent in one-stage Hypospadius repair. Can. J. Surg. Oct. 34(5): 507-509.

Turner-Warwick, R. (1983): Urethral surgery. In Glenn, I.; Boyce, G. eds: Urologic Surgery 3rd ed. Philadelphia, Lippincott, 689-719.

Turner-Warwick, R. (1989): Urethral stricture surgery. In Mundy, A.R. 3rd ed: Current Operative urology, 160-218.

Turner-Warwick, R. (1990): Complications of urethral surgery in the male. In complications of urologic surgery edited by smith & Ehrlich. 2nd ed. W.B. Saunders Copany. 430-475.

Valla, J.S.; Takvorian, P.; Dodat, H.; Glifer, R.B.; Chavrier, Y; Aubert, D.; Morisson-Lacombe, G.; Montupet, P.; Reinberg, O. and Doynjf, J.F. (1991): Single-stage correction of posterior Hypospadius (178 cases). Comparison of three techniques: Free skin graft, free bladder mucosa graft and Transverse pedicle preputial graft. Eur. J. Pediatr. Surg. 1(5): 287-290.

LEGENDS

Fig. 1: A three-sided rectangular skin incision on the urethral surface of the penis directly over the urethra.

Fig. 2: Penile urethral segment to be removed was freed from its tissue bed.

Fig. 3&4: A urethral segment was removed over the perviously placed urinary catheter. Traction suture was placed in the cut ends of the urethra. note the lumen of the urethra (held by forceps).

Fig. 5: Exposed venous segment.

Fig. 6: Harvested venous segment.

Fig. 7(A&B): The cut ends of the urethra and those of the graft were approximated and spatulated anaestomosis was performed.

Fig. 8: An ascending urethrogram of a normal urethra of the donkey.

Fig. 9 (A,B&C): An ascending urethrogram of a male donkey urethra showing the graft to be patent (2 months after the operation).

Fig.10: An ascending urethrogram showing fistula at the proximal end of the graft. (2 months after the operation).

Fig. 11: Anascending urethrogram of a male donkey (2 months after the operation) showing stricture at the proximal part of the graft.

Fig. 12: Vein lined with flat endothelium....H&E...X 200.

Fig. 13: Urethral lined with stratified squamous epithelium ...&E...X 100.

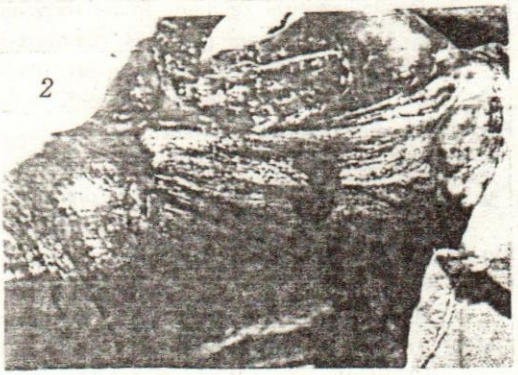
Fig. 14: Flattend epithelium of the vein at the lift side. Transformation into transitional epithelium at the right side. H&E X 200.

Fig. 15: Vein lined with well formed transitional epithelium. H&E X 200.

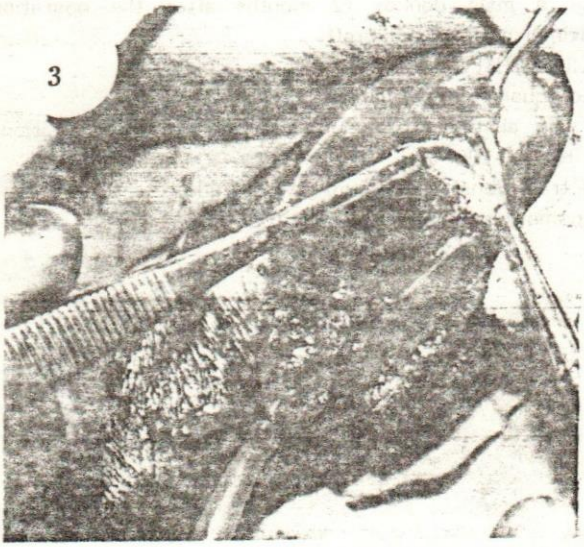
Fig. 16: Vein lined with stratified squamous epithelium. H&E X 100.

SUBSTITUTION URETHROPLASTY

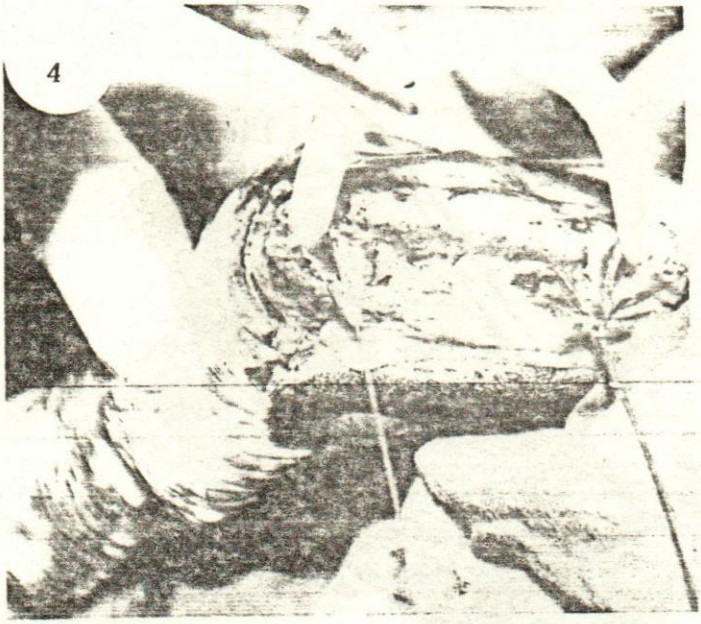
1



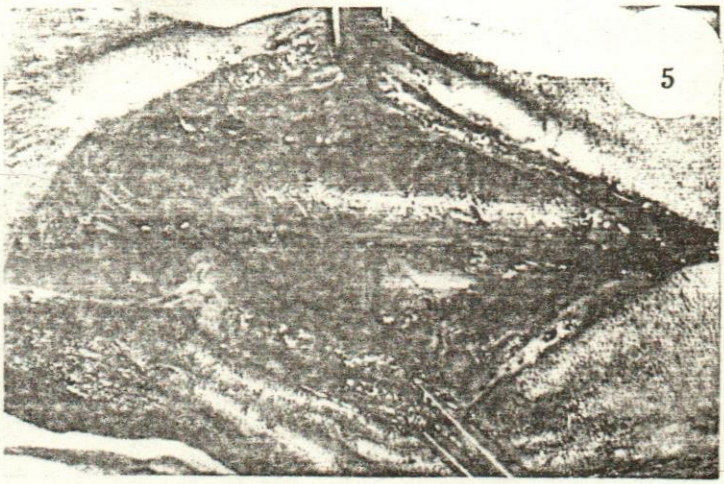
2



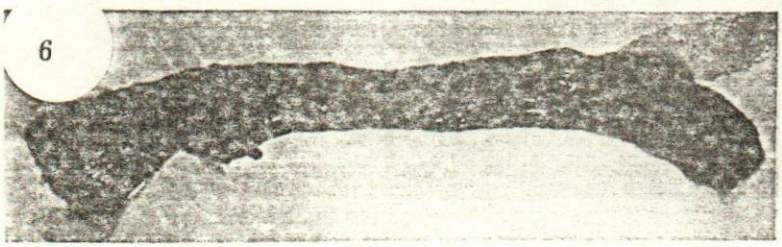
3



4



5



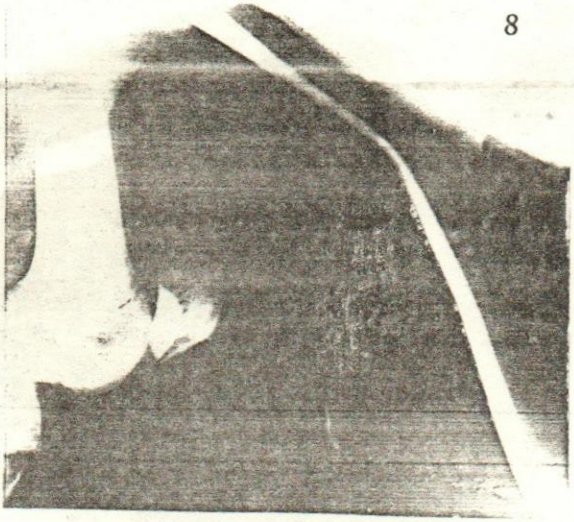
6


7

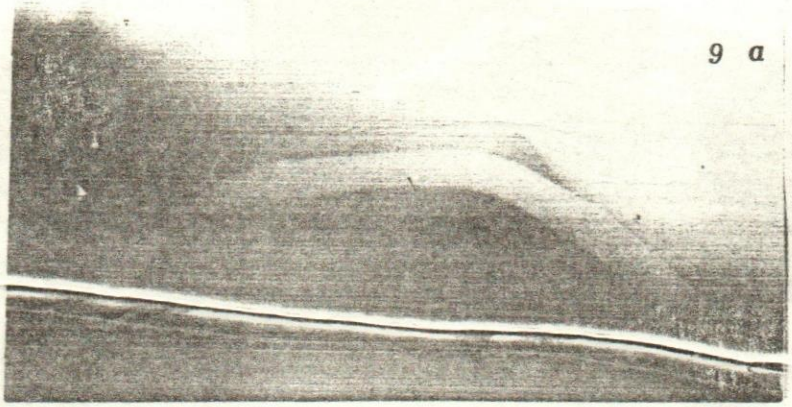

7 B

233

8

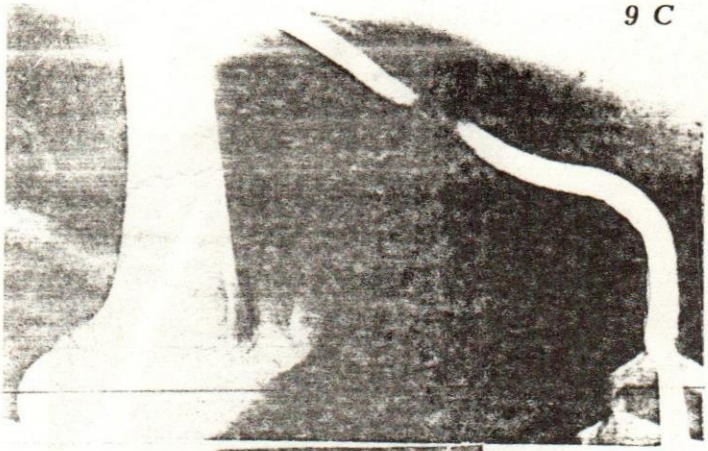


9 a

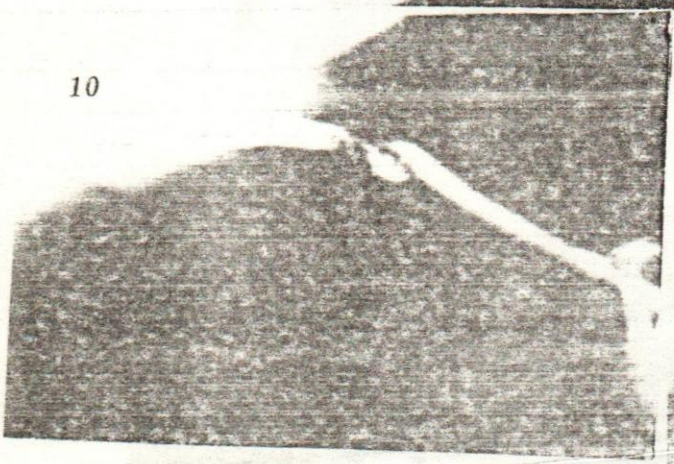


9 B

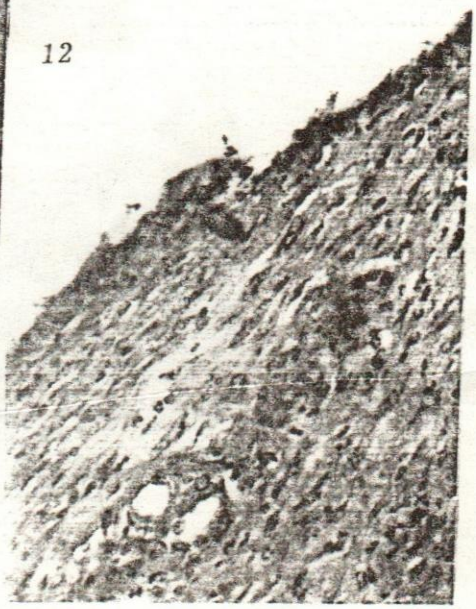
9 C



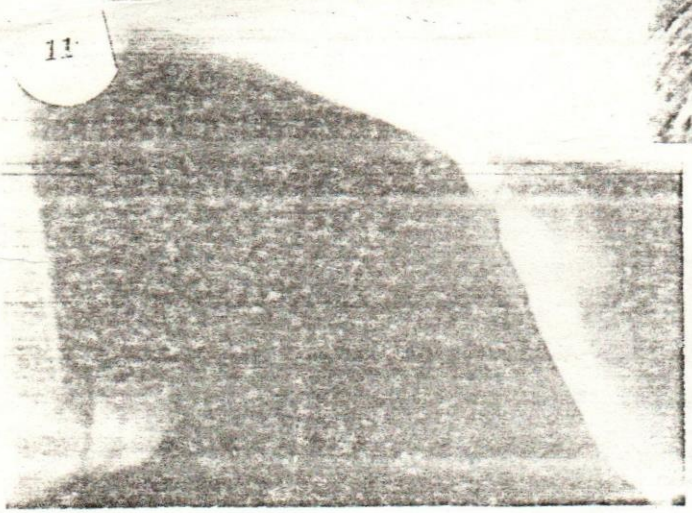
10



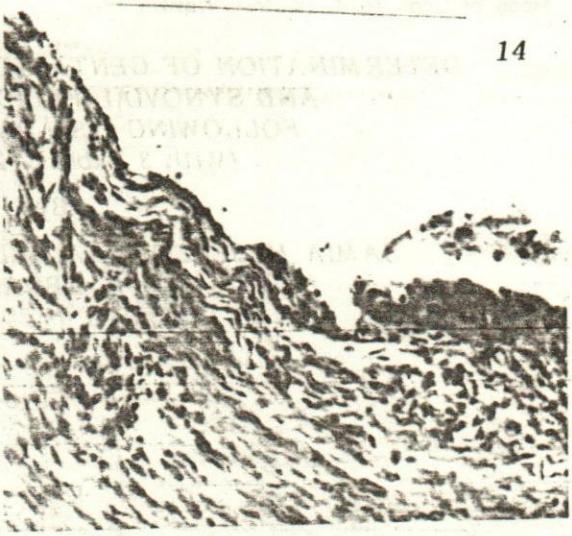
12



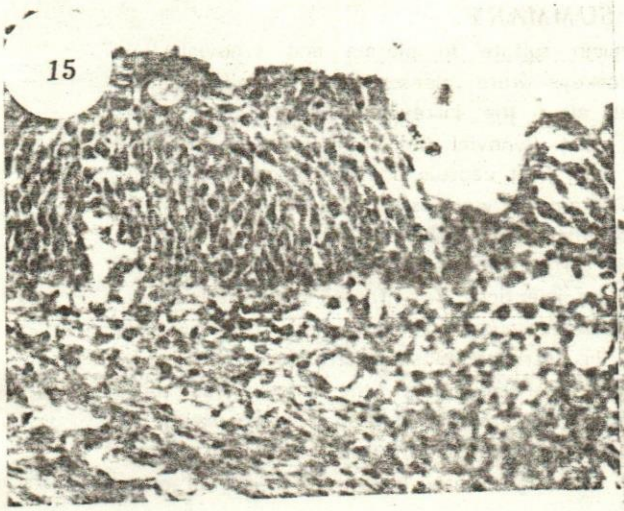
11



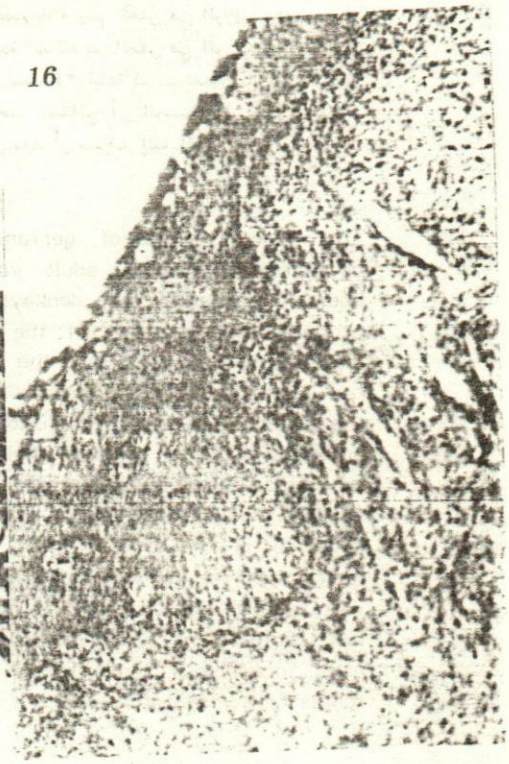
13



14



15



16