THE INTERNAL INGUINAL RING
A COMPARATIVE STUDY

By

K., A. D. Abulata; G. M. El-Khaligy; M. H. Rateb;

E. El-Gindy; G. M. Saied; A B. E. Abdallah

From the Surgery and Anatomy departments,

Kasr El-Aini Faculty of Medicine,

and the Faculty of Veterinary

Medicine, Cairo University,

INTRODUCTION

Inguinal hernia is a mammalian lesion due to the presence of the inguinal defect. This defect is present to allow extra-abdminal position of the testis, to attain the temperature required for the process of spermatogenesis. In birds, the testis is cooled by being situated near the air sac; (Romer and Parsons, 1977). This can explain the intra-abdominal position of the testis in non-mammalian species.

As the muscles and the fasciae of the anterior abdominal wall differentiate around the gubernaculum, the muscles split around it; (Arey, 1966, Davies, 1867, and Scorcer, and Farrington 1956). The hole through which the testis-and its cord-passes, is present in the lateral part of the defect, while its medial part is formed by the deepest fascial layer of the abdomen, supported by some fibres from the aponeurosis of the deepest muscle.

The anatomy of the inguinal defect in man and other mammals has been discussed by many pioneers; Davies, 1967 Last 1966, Getty, 1975, Anson, Morgan & McVay, 1960, Ashdown, 1963 and Miller, Christenes & Evans, 1964, yet few points need to be clarified :

In reptiles and bird (Hobbs, 1978, Romer & Parsons, 1977) stated that the three flank muscle sheets reach the pelvic bones and no inguinal defect is present.

The inguinal ligament stretches from the anterior superior iliac spine to the pubis, in those species where the external oblique muscle sheet reaches the pelvic bone. The ligament together with the underlying thick iliopubic band (known in human anatomy as the iliopectineal

Egypt. J Anat. Vol. 6, 27 — 44. 1983.

arch) bridges over the hilum of the pelvic limb. In some mammals the ligament does not reach the pelvic bone and the hilum is bridged by the iliopubic band alone (Hobbs, 1978).

Anson, *et al.* (1942) and Zimmerman and Anson (1967) stated that each muscle sheet is supplemented from both sides by a layer of fascia These two layers unite where the muscle or its aponeurotice extension stops. The most important of these layers of fascia is the one deep to the transversus muscle; the transversalis fascia.

In the fœtus, the gubernaculum develops before the flank muscles and their fasciae differentiate and grow ventrally (Arey, 1966 Scorcer and Farrington (1956). In the male the distal end of the gubernaculum swells markedly and it cleaves the way, allowing the testis to pass through the abdominal muscles Scorcer and Farrington 1956. Ashedown, 1963). This will cause widening of the internal ring (vaginal ring in animals) and increase the space between the muscles forming a permanent defect Warwick 1926, Moller-Sorensen & Wamberg, 1968). In the bitch widening of the internal ring occurs by excess fat around the gubernaculum (Ashdown 1963).

The muscular sheets in the region of the inguinal defect split around the cord and the testis. The external oblique splits medially Is the crura oblique splits medially as the crura of the internal oblique is manifested as the cremaster muscle dislocates from its lower end with the testis (Abulata *et al,* 1982). It is rudimentary in the female and of good bulk in the male. The split in the transversus layer in man is represented by the transversus arch above and the iliopublic tract below (Condon, 1978).

The most variant layer in the inguinal region is the transversus stratum. This is true in man (Anson, *et al.* 1960) and in animals, as it stops at the level of the umbilicus in equines and ruminants (Getty, 1975).

In domestic animals, a patent processus vaginalis is present (Getty, 1975. In man this is present in some cases, known as the « preformed sac» (Rains & Ritchie, 1975). Yet, hernia is rare in these animals compared to man (Hayes, 1974,Glassow, 1978). This may be attributed to the upright position of mankind, and it seems that the the inguinal hernia and the varicosity of the lower limb veins are the penalties mankind pays for the upright posture.

The internal ring (vaginal ring in animals) was described to be a round defect (Marcy, 1887, Griffith, 1978) U shaped defect with a laterally open end (Lytle, 1970, Rains & Ritchie 1975) and in some texts as an oval defect (Davies, 1967). It was also described to be a relativally mobile structure, pulled outwards and upwards by the contraction of the transversus muscle (Lytle, 1945).

The real factor in preventing the development of hernia was described to be the acute angle formed by the transversalis fascial sling at the medial border of the internal ring (Condon, 1978), the oblique course of the cord through the muscles mimicking the course of the ureter in the bladder wall (Zimmerman, 1952), and the upward and outward pull of the medial edge of the internal ring by the contraction of the muscles (Lytle, 1945).

In equines the course of the inguinal canal is oblique, while in the porince it is straight (Ashdown, 1963),but still the incidence of herna in them is less than nan (Hayes, 1974, Glassow, 1978).

The present work was conducted to point out the factors that could help in the prevention of the hernia formation.

MATERIAL AND METHODS

Dissection of the inguinal region was carried on fresh specimens as the dissection of the fascial layers was difficult in the preserved ones. This work was conducted on 30 cadavers as shown in the following table.

TABLE I

Type of Specimen	Sex					Total
	male	female	Full Term foetus.	Young	adults	
Human	6	4	10	—	—	10
Donkey	4	1	—	—	5	5
Sheep	2	—	—	—	2	2
Oxen	3	—	—	1	2	3
Dog	2	1	—	—	3	3
Cat	2	—	—	2	2	2
Swine	3	2	—	—	5	5
						30

RESULTS

In all examined cases the external oblique muscle reached the pelvic bone, the inguinal ligament is well formed and the external inguinal ring is found at its medial end.

In man, and domestic animals, behind the inguinal ligament, the thick iliopubic band of fascia appears to be divided into two parts; a part lateral to the vessels known in man as «iliopectinal arch»; and a medial part over and medial to the vessels (iliopubic band of man). The lateral part forms an arch over the psoas muscle, and the internal oblique muscle takes origin from this arch and not from the inguinal ligament. The medial end of this arch, seems to be fixed to the deep fascia on the pubopectineal eminence, and from this point the cremaster muscle takes origin (Fig 1, 2, 3).

The distribution of the internal oblique and the transversus muscles strata in the region of the inguinal defect are shown in tables II & III and (Fig. 4, 5, 6).

The internal ring forms an inverted Gama (γ) loop (Fig. 10, 11, 12, and diagram 1). When the latter was examined from inside (from the peritoneal aspect) it formed a crescent with its convexity looking medially. The lower end spreads over the pubic bone laterally, while the upper end seems to fade in the anterior abdominal wall (Fig. 7, 8). In the female the loop is not well manifested and the round ligament (gubernaculum) passes through the muscle slips similar to the nerves and vessels (Fig. 9). The examination from outside (from the muscle side) shows that the fascia medial and below the ring can be separated by careful dissection into two overlapping laminae. The anterior lamina can be traced laterlly to form the lateral edge of the ring, and continues there with the upper end of the crescentic medial edge of the ring. The posterior lamina, the transversalis fascia, forms the posterior Wall of the inguinal defect. It is prolonged behind the anterior lamina down onto the femoral sheath.

DISCUSSION

The inguinal defect is mandatory in mammals to allow the testis to have an extra-abdominal position, to be cooled to the degree of temperature required for spermatogenesis.

Table (II) : Internal oblique muscle stratum

Species	Origin	Cremaster	Arching fibres (Internal ring of animals	Conjoint tendon
Human	From the iliopectineal fascia (forming an arch over the iliopsoas muscle).	Arises from the most medial end of the Internal oblique muscle, (of good bulk in male, small in female).	Muscular	Present in one case
Equines			Covering the fascial ring	not present
Ruminants				
Carnivorous			Muscular Not covering the fascial ring.	
Pig				

Table (III) : Transversus muscle stratum

Species	Muscle	Fascia	Fascial (internal ring)
Human	— Aponeurotic — Arches higher than Int. oblique. — Partly covers the ring.	— Strong — Supplemented by aponeurotic fibres	Bilaminar arrangement (inverted gama loop is noticed
Equines Ruminants	Stops at the level of the umbilicus	— Unites with int[illegible] oblique fascia — Relatively thin	
Carnivorous	— Muscular — Arches higher than Int. obl. arch. — Partly covers the ring	Moderate strength	
Pig	— Aponeurotic — Arches higher than Int. obl. arch. — Not covering the ring	Strong	

Such defect must be supported by some structures to prevent the bulge of the intraperitoneal contents.

The various anatomical defects or weak points in the body are supported by one or more of the following mechanisms :

Closure by fibrous tissue stretching between the edges of the defect, as in the pleuro-peritoneal foramen of Bochdalek of the left diaphragmatic copula (Rains & Ritchie, 1975).

Blending of the lining of a cavity with the adventitial coat of the structures passing out of it; as with the vessels and nerves. This is well illustrated in the case of the femoral sheath and the cranial nerves (Davies, 1975).

Surrounding the defect by a sling cular sphincter, as in the case of the anal or cloacal aperature (Davies, 1975).

Surrounding the defect by a sling of muscles, as in the case of the œsophageal hiatus (Rains & Ritchie, 1975).

Duplication of the fascia around the defect as in the case of the sapheno-femoral junction, forming the doubled layer cribriform fascia (Last, 1966).

In the region of the inguinal defect, the barricade needed consists of both a static factor so that fatigue does not easily occur; and a dynamic factor (mobile reinforcement) to assist in overcoming additional functional strains.

The static support is the fibro-fascial ring, the internal ring (vaginal ring in animals). It is supplemented by other mechanical factors as, the acute angle created with the abdominal wall al the medial border of the ring (Anson, *et al* 1942), and the oblique course of the canal in the abdominal wall muscles simulating the ureter in the wall of the bladder (Zimmerman, 1952).

The dynamic component of the barricade is the muscular support achieved by both muscles related to the defect; the transversus and the internal oblique muscles. The aponeurotic edges of the internal ring are formed by the split of the transversus aponeurosis (Condon, 1978). They help in pulling the medial border of the ring upwards and outwards by the contraction of the transversus muscle (Lytle, 1945). The shutter action of the internal oblique muscle arch on the inguinal ligament is to close over the region of the internal ring, and thus forms the second muscular support (Zimmerman and Anson, 1867).

The present authors think that the most important factor in preventing the hernia formation is the shape of the ring. In this study the internal ring in man and animals has a bilaminar arrangement forming an inverted gama (γ) loop (Fig. 10, 11, 12, 13 and diag. 1). This can explain the appearance of the ring as round, oval and U shaped. The outward and upward pull on the medial edge of the ring can be explained :

The transversus aponeurotic fibres will pull the anterior lamina upwards, and the edge of the posterior lamna (the medial edge of the ring) will be straightened, while the lateral curving fibers will be pulled upwards (Diag. 2).

It is worth to add that in equines and ruminants the transversus muscle ends near the level of the umbilicus. In thise cases the inguinal defect will be composed of the internal oblique fascia (under its muscular arch) and the transversalis fascia. The role played by the crura of the internal ring, originating from the transversus muscle aponeurosis, is of no significance in such animals.

The course of the cord in the abdominal wall, could be of relative importance. Such course is relatively straight in the pig (Ashdown, 1963) and this may explain the higher incidence of inguinal hernia in this species (69/1000), compared to equines (1/1000) and less in other animals (Hayes, 1974). This is even less than the incidence in man (100/1000) Glassow, 1978).

The bilaminarity of the internal ring could be depicted in one of the drawings of Sir Astley Cooper (Condon, 1978).

This anatomical finding was tuilised surgically in another work by (Abulata, *et al,* (1982). As the medially displaced internal ring edge is pulled laterally by a continuous stitch till it allows only the tip of the little finger in the ring along with the cord (Diag. 3). By this technique the mechanism of the internal ring is restored.

SUMMARY

Comparative study of the region known as the inguinal defect was studied in 30 cases of different mammals (Man, dog, cat, donkey, ox, sheep and swine).

Some variations were noticed in the different species except the region of the internal ring (vaginal or fascial ring of animals) situated in the deepest fascia of the abdominal wall.

The internal ring is composed of two laminae forming an inverted gama (γ) loop.

The authors suggest that this specific arrangement is the main, if not the sole, mechanism against hernia delvelopment in the mammalian species.

REFERENCES

1. Abulata K.A., Rateb M.H., Fawzy T. M., Saleh E.A., Rashad H.M.· El-Etreby Kh. and Nasef A.I. (1982) : The repair of inguinal hernia : an anatomical concept and its surgical implication. J. Egypt. Med. Assoc. 65 : 11.

2. Anson B.I., Morgan E. H. and Mc Vay C.B. (1942) : Quart. Bull. Northwest Univ. Med. Sch. 16 : 128. (Quoted by Zimmerman and Anson, 1967).

3. Anson B.I., Morgan E.H. and McVay C.B. (1960 : Surgical anatomy of inguinal region based upon a study of 500 body halves. Surg. Gyn. Obst. 111:707.

4. Arey L. B. (1966) : Developmental anatomy. 7th Ed. Philadelphia, Saunders Co. pp. 329—335.

5. Ashdown R.R. (1963) : The anatomy of inguinal canal in the domesticated mammals. The Vet. Rec. 75 : 1345.

6. Condon R.E. (1978) : The anatomy of the inguinal region and its relationship to groin hernia. In : Hernia, Edts. Nyhus, L.A. and Condon R.E., 2nd Ed. Philadeplphia, Lippincott Co. pp. 14—54.

7. Davies D.V. (1967) : Gray's Anatomy, Descriptive and Applied. 34th Ed. London, Longmann's Co. pp. 630—642.

8. Getty R. (1975) : Edts. Sisson and and Grossman's The anatomy of Domestic animals. 5th Ed. Philadelphia, Saunder's Co. pp. 95, 407, 821, 1266, 1519, 1535, 1813.

9. Glassow F. (1978) : Shouldice repair for inguinal hernia. In : Hernia, Edts Nyhus L.M. and Condon R.E. 2nd Ed. Philadelphia, Lippincott. pp. 163—174.

10. Griffith C.A. (1978) : The Marcy repair of indirect inguinal hernia. In : Hernia, Edts Nyhus and Condon. 2nd Ed. Philadelphia, Lippincott Co. pp. 137—152.

11. Hayes H. M. (1974) : Congenital Umbilical and inguinal hernia in Cattle, Horses, Swine, Dogs and Cats. Am. J. Vet. Res. 35 : 839.

12. Hobbs J.T. (1978) : The significance of the inguinal ligament In : Hernia. Ehts, Nyhus Condon 2nd Ed. Philadelphia, Lippincott Co. pp. 67—77.

13. Last R.J. (1966) Anatomy, Regional and Applied. 4th Ed. London, Churchill Co. pp. 197—200.

14. Lytle W.J. (1945) : The internal ring. Br. Surg. 32 : 441.

15. Lytle W.J. (1970) : The deep inguinal ring, development, function and repair. Br. J. Surg. 57 : 531.

16. Marcy H.O. (1887) : The cure of hernia. J.A.M.A. 78 : 589.

17. Miller M.F., Christenen G.C. and Evans H.E. (1964) : The anatomy of the dog. Philadelphia, Saunders Co.

18. Moller Soresen A and Wamberg K. (1968) : Hernia, In : Veterinary Encyclopedia, Vol. 2, Diagnosis and treatment. Edt. Wamberg K., Copenhagen, Denmark, Medical book Co. pp. 1177—1197.

19. Rains A.J. and Ritchie H.D. (1975) Bailey and Loves's short practice of surgery. 16th Ed. London, Lewis Co. pp. 1059—1987.

20. Romer A.S. and Parsons T.S. (1977) Vertebrate body, 5th Ed. Philadelphia. Saunders Co. pp. 36—602.

21. Scorcer C.G. and Farrington G. H. (1956) : Congenital anomalies of the testes. Arch. Dis. Child. Dis. Child. 31 : 198.

22. Warwick B.L. (1926) : A study on hernia in Swine. Agric. Sta. Bull. University of Winconsin. 69 : 12. (Quoted by Ashdown, 1963).

23. Zimmerman L.M. (1952) : Surgical Clinics of North America. 35 : 135. (Quoted by Zimmerman and Anson, 1967).

24. Zimmerman L.M. and Anson B.J. (1967) : Anatomy and Surgery of hernia. 2nd Ed. Baltimore, Williams & Wilkins Co. pp. 102—141.

LEGENDS FOR FIGURES

Fig. 1: Dissection of the right inguinal region of a female pig (External view).

Fig. 2 : Dissection of the right inguinal region of a male pig (External view).

Fig. 3 : Dissection of the right inguinal region of a male dog (External view).

Abbreviations on Figs. 1, 2, 3.

C. - Cremaster muscle (Weak).

C'. - Cremaster muscle (Good bulk).

I.O.M - Internal oblique muscle.

S.P. - Space for psoas muscle.

I.P. - Iliopectineal arch.

I.L. - Inguinal ligament.

I.P.F. - Iliopubic fascia.

I.P.F.A - Iliopubic fascial arch.

CX. - Origin of cremasltric muscle (from the fascia at the medial end of the fascial bridge over the iliopsoas muscle (See text)..

Fig. 4 : Dissection of Right inguinal region in Human (Internal view).

I.O.M - Internal oblique muscle (reflected).

I.O.A. - Internal oblique arch.

T.M.A. - Transverse muscle arch. (arrows showing higher transversus arch).

Fig. 5 : Dissection of left inguinal region in a female dog (Internal) view).

I.O.M. - Internal oblique muscle (reflected).

I.O.A. - Internal oblique muscle (arch).

T. M. - Transverse muscle (reflected).

T.M.A. - Transverse muscle (arch).

E.O.M. - External oblique muscle.

(arrows : showing higeher transversus muscle arch).

Fig. 6 : Dissection of left inguinal region of a male pig (Internal view).

I.O.M. - Internal oblique muscle (reflected).

I.O.A. - Internal oblique muscle (arch).

T.M. - Transversus muscle.

T.M.A. - Transversus muscle (arch).

(Notice the relation between the internal oblique and transversus muscles and their relative higher arches than in man and dog).

Fig. 7 : Dissection of the left inguinal region in a male donkey. (Internal view). The arrows show internal ring forming a cresentric convex edge medially. Its lower limb extends over the pelvic bone ."X").

Fig. 8 : Dissection of the Right inguinal region in an ox (Internal view) (same as Fig. 7).

Fig. 9 : **Dissection of the left inguinal** region of a **female donkey (Internal view)** No. definite inguinal defect is present.

C. (Cremaster muscle).

I.O.M. - Internal oblique muscle (arrows: showing the round ligament (gubernaculum) passing through the abdominal wall).

Fig. 10 : Dissection of the left inguinal region of a male pig (External view). Showing the Internal ring S.C. spermatic cord. (arrows : showing two laminae with a closed lateral border and the looping around the cord.

P.l. - Posterior lamina passes behind. the A. l Anterior lamina (forming an inverted gama loop).

Fig. 11 & 12 : Dissection of left Inguinal region of human (Male). External view. Showing the inverted gama loop. Internal ring. Notice the laterally closed internal ring.

T.M. - Transverse muscle (reflected).

I.O.M. - Internal oblique muscle (reflected).

S.C. - Spermatic cord.

A.L. - Anterier lamina seperated and pulled down.

P.L. - Posterior lamina (Notice the posterior direction of its fibers).

Fig. 13 : **Dissection of left inguinal region of Human (female External view. Showing the inverted (ɣ) gama loop internal ring.**

T.M. - Transverse **muscle (reflected).**

I.O.M. - Internal oblique muscle (reflected).

E.O.M. - External oblique muscle (reflected).

I. L. - Inguinal ligament.

A. L. - Anterier lamina.

P. L. - Posterior lamina.

Diagram 1 : The anterior lamina forms the lower edge of the inguinal defect, and the lower lip of the internal ring. It passes laterally to form the lateral edge and the upper lip of the ring. There, it forms the posterior lamina and the medial edge of the ring and then continues downwards and posterior to the anterior lamina onto the femoral sheath.

Diagram 2 : On muscular contraction the widely gaped inverted gama loop ring, will be smaller with resultant lateral pull on the medial edge of the ring.

Diagram 3 : Surgical correction depending on the anatomical findings. The markedly displaced medial border is pulled laterally, restoring the inverted gama loop.

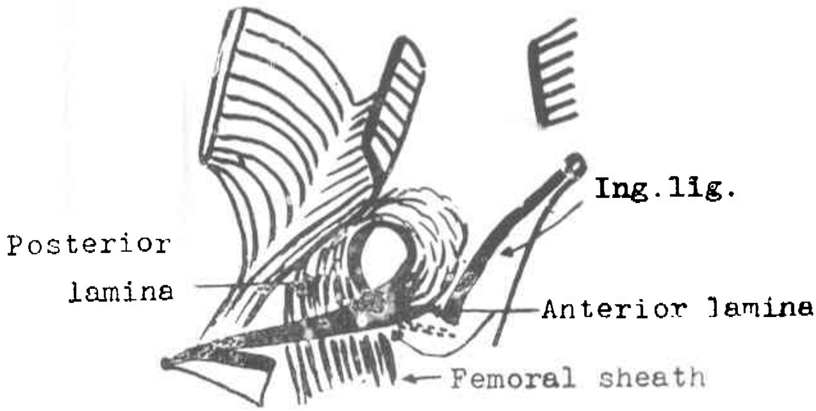
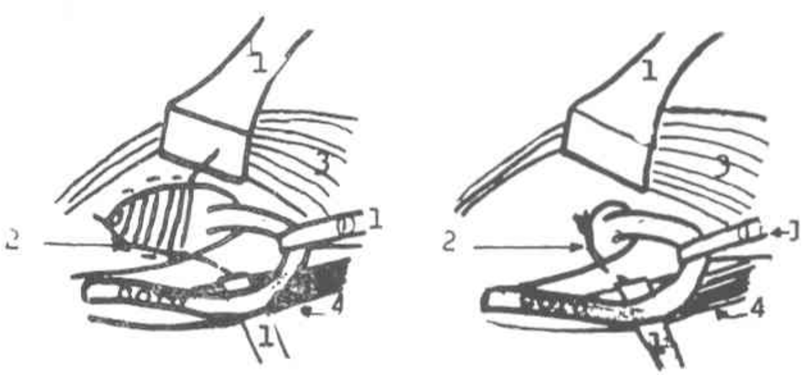


Diagram (1)

Diagram (2)



1-Retractor 2-Internal ring 3-Muscle arch(Int.Obl.&Transv.) 4-Ext.Obl.

Diagram (3)

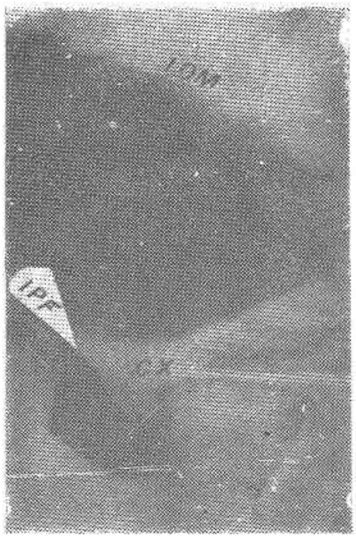


Fig. (1)

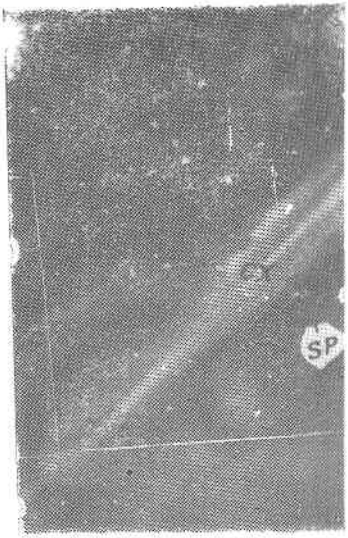


Fig. (3)

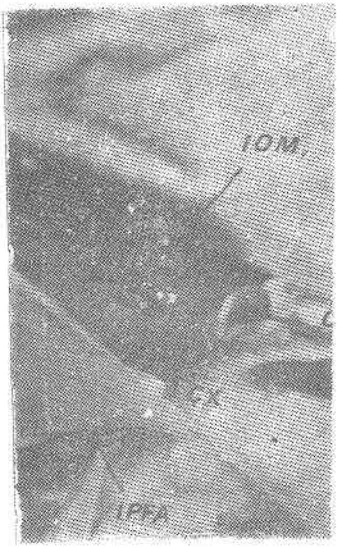


Fig. (2)

Fig. (4)

Fig. (5)

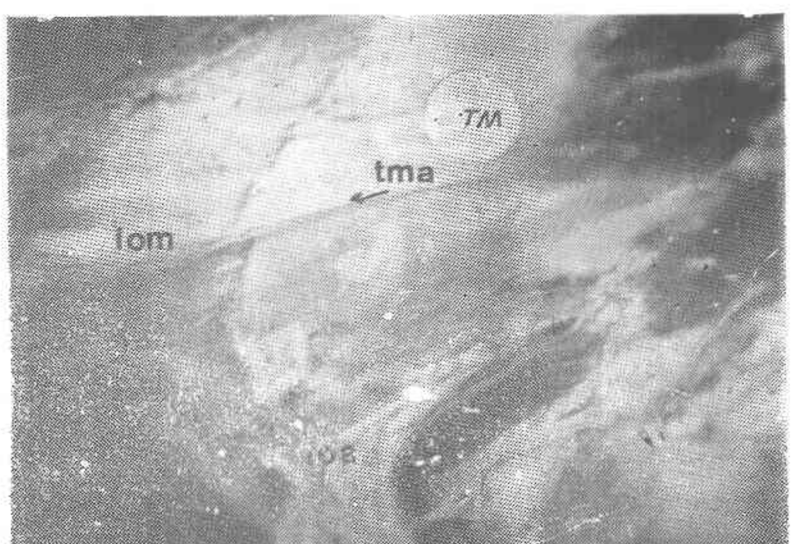


Fig. (6)

Fig. (7)

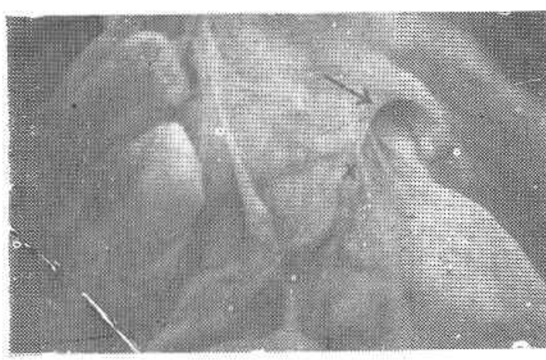


Fig. (8)

Fig. (9)

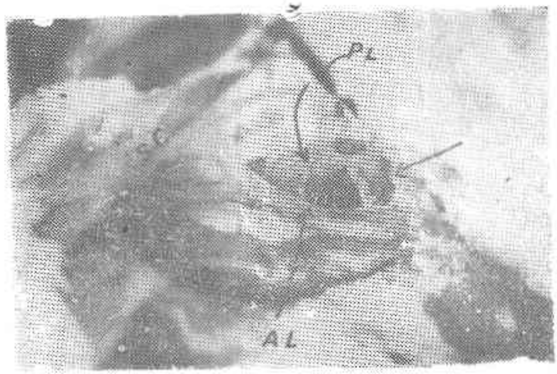


Fig. (10)

Fig. (11)

Fig. (12)

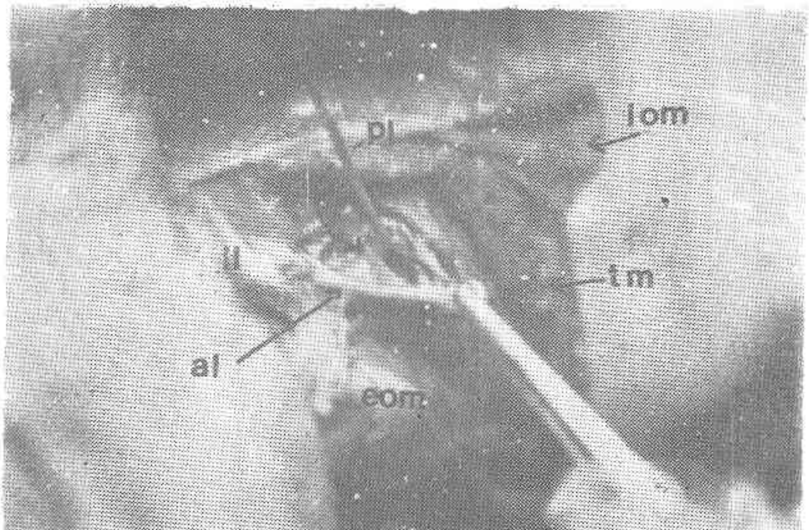


Fig. (13)