

RESULTS

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The Nasal Mucosa

Control Animals:

The nasal biopsy specimens from control animals showed pseudostratified columnar ciliated epithelium with goblet cells. No areas of squamous metaplasia or ciliary destruction were seen in any of the specimens taken from the control animals. The subepithelial layer showed fair distribution of seromucinous glands in the specimens taken from different sites of both nasal sides. No inflammatory cellular infiltration was seen in any of the specimens and no histological difference was detected between both sides of the nose. (Fig. 22)

Histopathological Changes of the Nasal Mucosa in Rats

Subjected to Unilateral Nostril Closure:

After One Week, (Table 3 and Fig. 15):

On the Open Side:

Examination of the nasal mucosa on the open side after one week revealed patchy areas of squamous metaplasia and ciliary destruction and venous congestion in

3 out of 18 rats (16.66%). No inflammatory cellular infiltration, no increase of goblet cells or subepithelial glands were seen. In the other 15 animals (83.33%) the mucosa looked like that of control animals.

On the Closed Side:

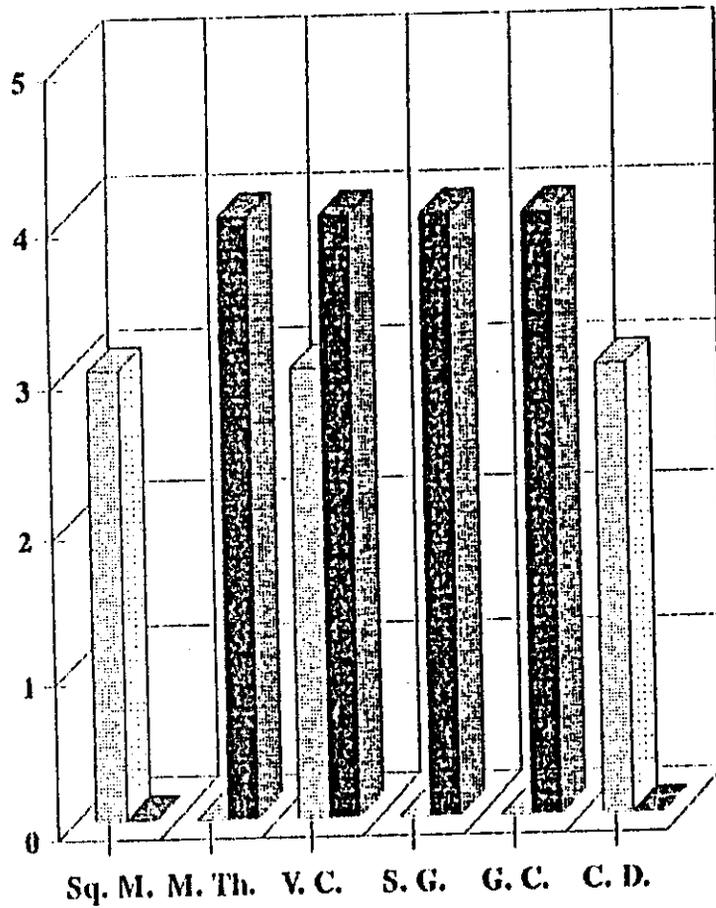
In 4 out of 18 rats (22.22%) there was increased secretory activity in the form of mild increase of goblet cells and subepithelial glands. There were also mild increase of mucosal thickness and venous congestion in these 4 animals. No squamous metaplasia, no ciliary destruction or inflammatory cellular infiltration were seen. The remaining 14 animals (77.77%) showed normal nasal mucosa.

Although the changes of the nasal mucosa on both sides were mild, there was a significant increase in the number of rats showing increase of mucosal thickening, subepithelial glands and goblet cells more on the closed than on the open side ($P < 0.01$).

Table (3): Showing the changes of the nasal mucosa after one week unilateral nostril closure.

	Open side		Closed side		Z test	P
	No	%	No	%		
Squamous metaplasia.	3	16.66%	0	---	1.897	P <0.05
Increased mucosal thickness.	0	---	4	22.22%	2.267	P <0.01
Inflammatory cellular infiltration.	0	---	0	---	---	---
Venous congestion.	3	16.66	4	22.22%	0.42	>0.05
Increased subepithelial glands.	0	---	4	22.22%	2.267	P <0.01
Increased goblet cells.	0	---	4	22.22%	2.267	P <0.01
Ciliary destruction.	3	16.66%	0	---	1.897	P >0.05

FIG. (15): THE NUMBER OF RATS SHOWING CHANGES OF NASAL MUCOSA AFTER ONE WEEK OF UNILATERAL NOSTRIL CLOSURE



Open side	3	0	3	0	0	3
Closed side	0	4	4	4	4	0

□ Open side ■ Closed side

- Sq. M.: Squamous Metaplasia.
- M. Th.: Increased Mucosal Thickness
- V. C.: Vascular Congestion.
- S. G.: Increased Suprapitheatial Glands.
- G. C.: Increased Goblet cells.
- C. D.: Ciliary Destruction.

After Two Weeks, (Table 4 and Fig. 16):

On the Open Side:

In 8 out of 18 rats (44.4%) squamous metaplasia, venous congestion and ciliary destruction were seen. In 4 of these 8 rats (22.2%), moderate increase of mucosal thickness was seen while increased subepithelial glands was seen in 2 rats (11.11%) and increase of goblet cells was seen in 3 rats (16.66%). Inflammatory cellular infiltration was not seen.

On the Closed Side:

Marked increase of mucosal thickness was seen in 11 out of 18 rats (61.11). In 7 of them (38.88%) marked venous congestion was seen and in 10 rats, there was increased number of subepithelial glands. 6 rats (33.33%) showed increased number of goblet cells in different sites. No squamous, metaplasia no ciliary destruction or inflammatory cellular infiltration were seen on the closed side of any of the animals of this group.

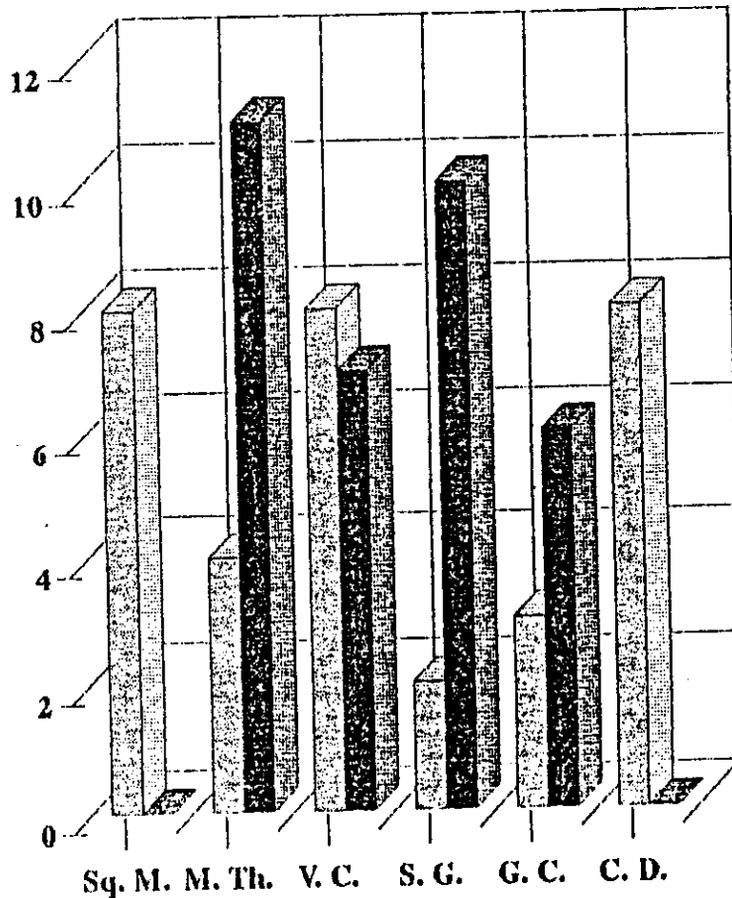
So there was significant increase in the number of rats showing increased mucosal thickening and increase of subepithelial glands in the closed side more than in the open side of the nose. (P <0.01) while there was more significant increase in the number of rats showing ciliary destruction and sparsely distributed squamous metaplasia in the open side more than in the closed side (P <0.001).

As regards vascular dilatation and increased goblet cells there was no significant difference.

Table (4): Showing the changes of the nasal mucosa after two weeks of unilateral nostril closure.

	Open side		Closed side		Z test	P
	No	%	No	%		
Squamous metaplasia.	8	44.4%	0	---	3.2	<0.001
Increased mucosal thickness.	4	22.22%	11	61.11%	2.366	<0.01
Inflammatory cellular infiltration.	0	---	0	---	---	---
Venous congestion.	8	44.44	7	38.88%	0.33	>0.05
Increased subepithelial glands.	2	11.11%	10	55.5%	2.82	<0.01
Increased goblet cells.	3	16.66%	6	33.33%	1.15	<0.05
Ciliary destruction.	8	44.44%	0	---	3.207	>0.001

FIG. (16): THE NUMBER OF RATS SHOWING CHANGES OF NASAL MUCOSA AFTER TWO WEEKS OF UNILATERAL NOSTRIL CLOSURE.



Open side	8	4	8	2	3	8
Closed side	0	11	7	10	6	0

■ Open side ■ Closed side

After One Month, (Table 5 and Fig. 17):

On the Open Side:

There was marked venous congestion in 14 out of 18 rats (77.77%). In 9 of these rats (50%) squamous metaplasia was seen and in 11 rats (61.11%) there was sparsely distributed areas of ciliary destruction. Only 3 rats (16.66%) showed increased goblet cells and increased subepithelial glands and in 5 rats (27.77%) marked increase of mucosal thickness was seen.

On the Closed Side:

Marked increase of mucosal thickening and subepithelial glands was seen in 12 out of 18 rats (66.66%) and increased goblet cells was seen in 10 rats (55.5%).

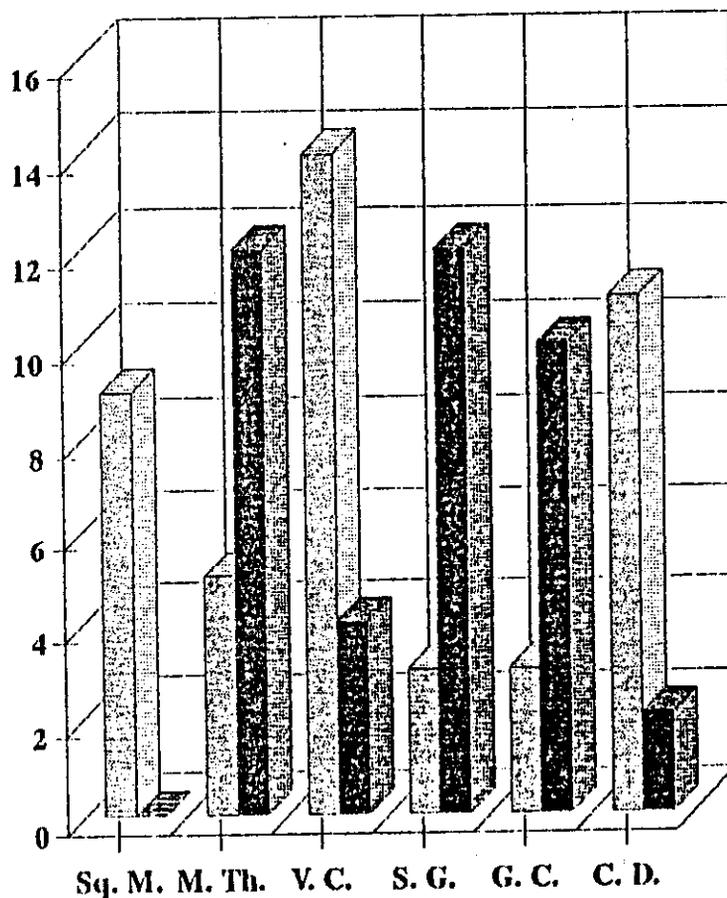
Two rats (11.1%) showed inflammatory cellular infiltration with ciliary destruction and 4 rats (22.2%) showed venous congestion. No squamous metaplasia was seen in the closed side.

These results showed that there was a significant increase in the number of rats showing increased mucosal thickening, subepithelial glands and goblet cells more on the closed side than on the open side (P <0.01) while there was a significant increase in the number of rats showing ciliary destruction, venous congestion and squamous metaplasia more on the open side than on the closed side of the nose (P <0.001).

Table (5): Showing the changes of the nasal mucosa after one month unilateral nostril closure.

	Open side		Closed side		Z test	P
	No	%	No	%		
Squamous metaplasia.	9	50%	0	---	3.46	<0.001
Increased mucosal thickness.	5	27.77%	12	66.6%	2.33	<0.01
Inflammatory cellular infiltration.	0	---	2	11.11%	1.45	>0.05
Venous congestion.	14	77.77%	4	22.22%	3.33	>0.001
Increased subepithelial glands.	3	16.66%	12	66.66%	3.04	<0.01
Increased goblet cells.	3	16.66%	10	55.5%	2.04	<0.01
Ciliary destruction.	11	61.11%	2	11.11%	3.12	>0.001

FIG. (17): THE NUMBER OF RATS SHOWING CHANGES OF NASAL MUCOSA AFTER ONE MONTH OF UNILATERAL NOSTRIL CLOSURE



Open side	9	5	14	3	3	11
Closed side	0	12	4	12	10	2

Open side
 Closed side

After Two Months, (Table 6 and Fig. 18):

On the Open Side:

Examination of the nasal mucosa on the open side after two months revealed changes in 7 rats while the remaining 11 rats showed normal mucosa. Patches of squamous metaplasia with venous congestion and ciliary destruction were seen in 7 rats (38.88%). In 3 of these rats (16.66%) there were increase of subepithelial glands and goblet cells. Increased mucosal thickness was seen in 4 rats (22.22%). No inflammatory cellular infiltration was seen.

On the Closed Side:

In 5 animals (27.77%), changes of the nasal mucosa was seen while the remaining 13 rats showed normal mucosa. Increased mucosal thickness, subepithelial glands were seen in 5 rats (27.77%). 4 rats (22.22%) showed venous congestion and areas of ciliary destruction were seen in only 2 animals (11.11%). No inflammatory cellular infiltration or squamous metaplasia were seen on that side.

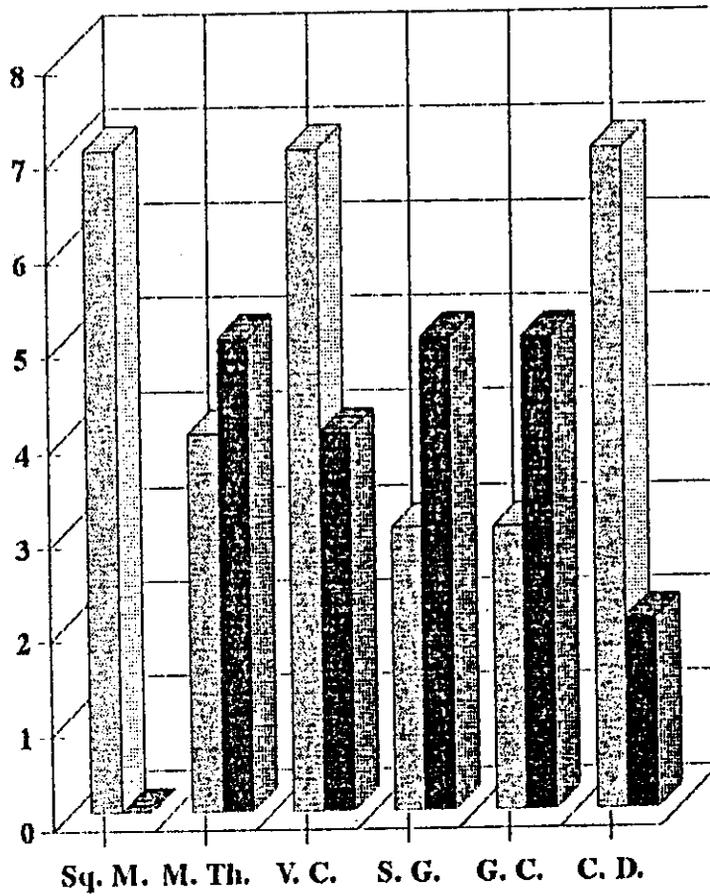
These results showed that there was a significant increase in the number of rats showing squamous metaplasia, (P <0.01) and ciliary destruction (P <0.05) more on the open side than on the closed side.

As regards increased mucosal thickness, increased subepithelial glands and increase of goblet cells there was no statistically significant difference between the number of rats showing these changes in the closed and open sides although these changes were seen in a more number of rats in the closed than on the open side.

Table (6): Showing the changes of the nasal mucosa after two months of unilateral nostril closure.

	Open side		Closed side		Z test	P
	No	%	No	%		
Squamous metaplasia.	7	38.88%	0	---	2.94	<0.01
Increased mucosal thickness.	4	22.2%	5	27.77%	0.38	<0.05
Inflammatory cellular infiltration.	0	---	0	---	--	---
Venous congestion.	7	38.88%	4	22.22%	1.1	>0.05
Increased subepithelial glands.	3	16.66%	5	27.77%	0.80	<0.05
Increased goblet cells.	3	16.66%	5	27.77%	0.80	<0.05
Ciliary destruction.	7	38.8%	2	11.11%	1.92	>0.05

FIG. (18): THE NUMBER OF RAT'S SHOWING CHANGES OF NASAL MUCOSA AFTER TWO MONTHS OF UNILATERAL NOSTRIL CLOSURE



Open side	7	4	7	3	3	7
Closed side	0	5	4	5	5	2

☐ Open side ■ Closed side

After Three Months, (Table 7 and Fig. 19):

On the Open Side:

6 out of 18 rats (33.33%) showed changes of the nasal mucosa while 12 animals exhibited normal nasal mucosa. Patchy squamous metaplasia, mild venous congestion and areas of ciliary destruction were seen in 6 rats (33.3%). In 2 of these rats (11.1%) there was marked increase of subepithelial glands and goblet cells. 3 rats (16.66%) showed increased mucosal thickness and no rat showed inflammatory cellular infiltration.

On the Closed Side:

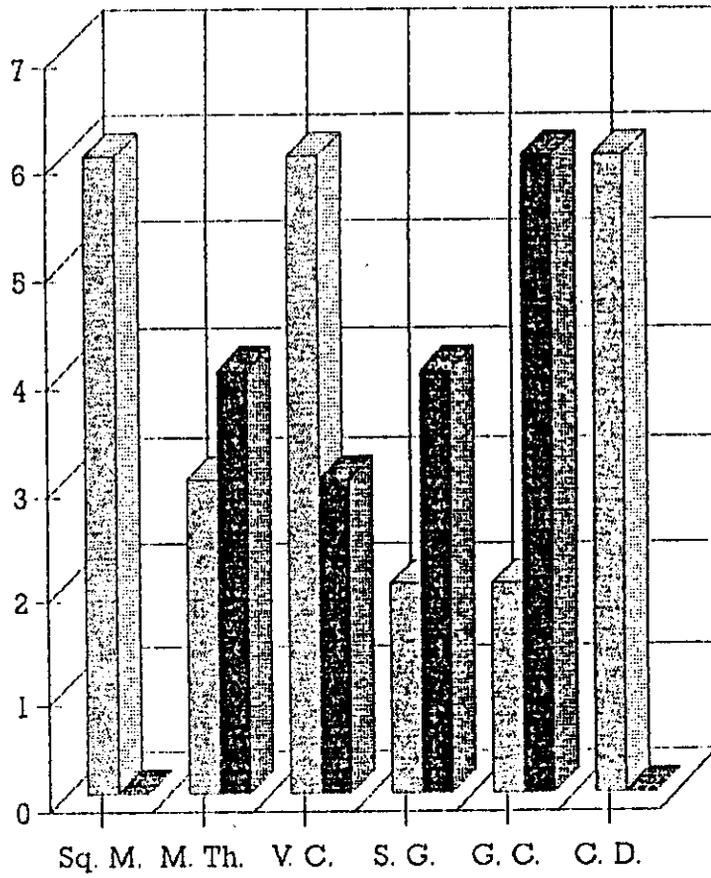
6 rats (33.3%) showed changes of the nasal mucosa in the form of marked increase of goblet cells. In 4 of them there was increase in mucosal thickness and subepithelial glands and in 3 rats there was marked vascular congestion. No squamous metaplasia no inflammatory cellular infiltration or ciliary destruction were seen.

This showed that, there was a significant increase in the number of rats showing squamous metaplasia and ciliary destruction more on the open side than on the closed side of the nose while there was no significant difference between open and closed sides as regards the number of rats showing increase of mucosal thickness, subepithelial glands although these changes were seen in a slightly more number of rats on the closed side ($P > 0.05$).

Table (7): Showing the changes of the nasal mucosa after three months of unilateral nostril closure.

	Open side		Closed side		Z test	P
	No	%	No	%		
Squamous metaplasia	6	33.33%	0	---	2.683	<0.01
Increased mucosal thickness.	3	16.66%	4	22.22%	0.42	<0.05
Inflammatory cellular infiltration	0	---	0	---	--	---
Venous congestion	6	---	3	16.66%	1.15	>0.05
Increased Subepithelial glands	2	11.11%	4	22.22%	0.89	<0.05
Increased goblet cells	2	11.11%	6	33.33%	1.66	<0.05
Ciliary destruction	6	33.33	0	---	--	>0.01

FIG. (19): THE NUMBER OF RATS SHOWING CHANGES OF NASAL MUCOSA AFTER THREE MONTHS OF UNILATERAL NOSTRIL CLOSURE



Open side	6	3	6	2	2	6
Closed side	0	4	3	4	6	0

Open side
 Closed side

Table (8): Showing the effect of time on different histopathological changes on the open side of the nose.

Histopathological changes	1- Week		2- Weeks		1- Month		2- Months		3- Months	
	No	%	No	%	No	%	No	%	No	%
Squamous metaplasia	3	16.66%	8	44.4%	9	50%	7	38.88%	6	33.33%
Increased mucosal thickness	0	---	4	22.22%	5	27.77%	4	22.2%	3	16.66%
Inflammatory cellular infiltration	0	---	0	---	0	---	0	---	0	---
Venous congestion	3	16.66%	8	44.44%	14	77.77%	7	38.88%	6	---
Increased Subepithelial glands	0	---	2	11.11%	3	16.66	3	16.66%	2	11.11%
Increased goblet cells	0	---	3	16.66%	3	16.66%	3	16.66%	2	11.11%
Ciliary destruction	3	16.66%	8	44.44%	11	61.11%	7	38.8%	6	33.33%

FIG. (20): SHOWING THE EFFECT OF TIME ON DIFFERENT HISTOPATHOLOGICAL CHANGES ON THE OPEN SIDE OF THE NOSE.

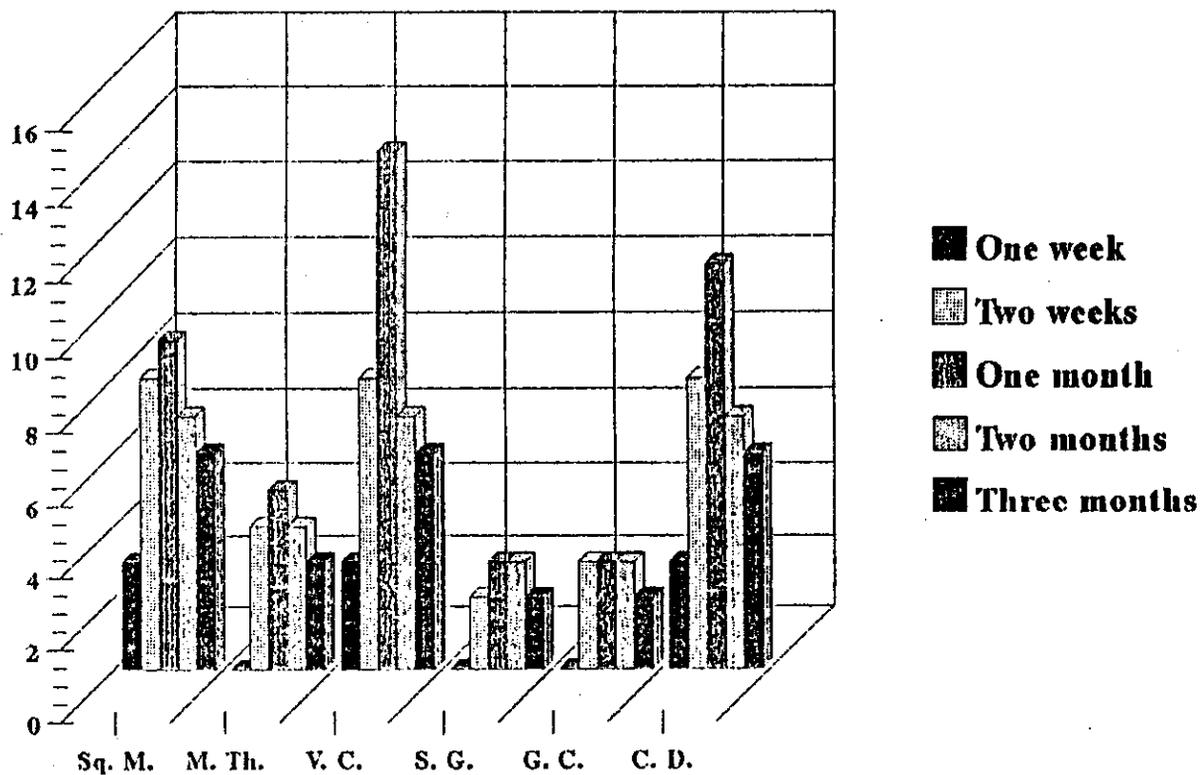
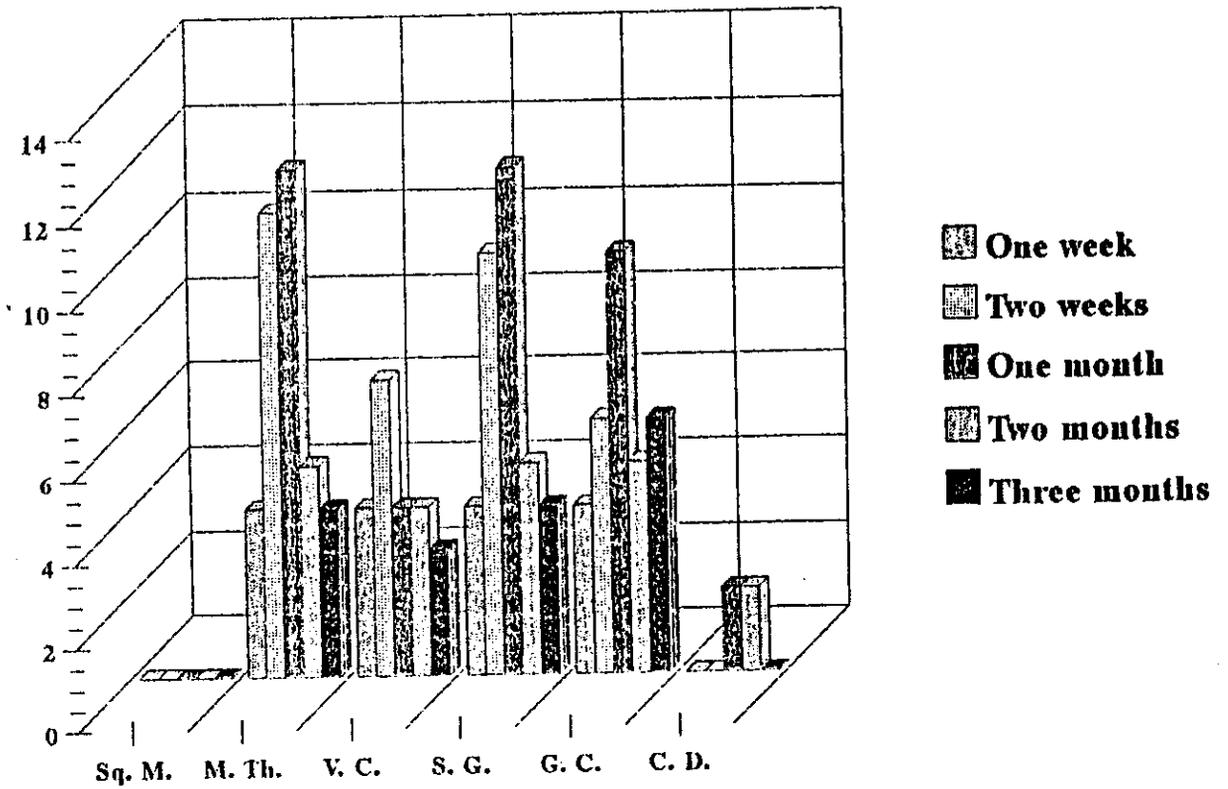


Table (9): Showing the effect of time on different histopathological changes on the closed side of the nose.

Histopathological changes	1- Week		2- Weeks		1- Month		2- Months		3- Months	
	No	%	No	%	No	%	No	%	No	%
Squamous metaplasia	0	---	0	---	0	---	0	---	0	----
Increased mucosal thickness	4	22.22%	11	61.11%	12	66.6%	5	27.77%	4	22.22%
Inflammatory cellular infiltration	0	---	0	---	2	11.11%	0	---	0	----
Venous congestion	4	22.22%	7	38.88%	4	22.22%	4	22.22%	3	16.66%
Increased Subepithelial glands	4	22.22%	10	55.5%	12	66.66%	5	27.77%	4	22.22%
Increased goblet cells	4	22.22%	6	33.33%	10	55.5%	5	27.77%	6	33.33%
Ciliary destruction	0	---	0	---	2	11.11%	2	11.11%	0	----

FIG. (21): SHOWING THE EFFECT OF TIME ON DIFFERENT HISTOPATHOLOGICAL CHANGES ON THE CLOSED SIDE OF THE NOSE.



Histopathological Changes of the Nasal Mucosa in Rats
Subjected to Bilateral Nostril Closure: (Group II)

After Three Days:

Examination of the nasal mucosa of 8 rats subjected to bilateral nasal obstruction for 3 days revealed slight increase of goblet cells in both sides of the nose in 2 rats.

No squamous metaplasia, no inflammatory cellular infiltration or ciliary destruction were seen in any of the animals.

After Five Days:

In 2 out of 8 rats mild increase of mucosal thickness, mild increase of goblet cells with venous congestion were seen. No squamous metaplasia, no inflammatory cellular infiltration or ciliary destruction were seen on both sides in all rats in this subgroup.

After One Week:

In 2 out of 8 rats there was mild increase of secretory activity in the form of increase number of goblet cells and increased subepithelial glands. There was also mildly increased mucosal thickness in these 2 rats in addition to mild venous congestion.

After Nine Days:

Marked increase of goblet cells was seen in 3 out of 6 rats. There were increased mucosal thickness with increased subepithelial glands and venous congestion in 2 rats. In one these two rats, inflammatory cellular infiltration and patchy areas of ciliary destruction were seen in different sites of the nose.

Table (10): Showing the changes of the nasal mucosa following bilateral nostril closure.

	After 3 days	After 5 days	After one week	After 9 days
Squamous metaplasia	---	---	---	---
Increased epithelial thickness	---	2	2	2
Inflammatory cellular infiltration	---	---	---	1
Venous congestion	---	2	2	2
Increased Subepithelial glands	---	---	2	2
Increased goblet cells	2	2	2	3
Ciliary destruction	---	---	---	1

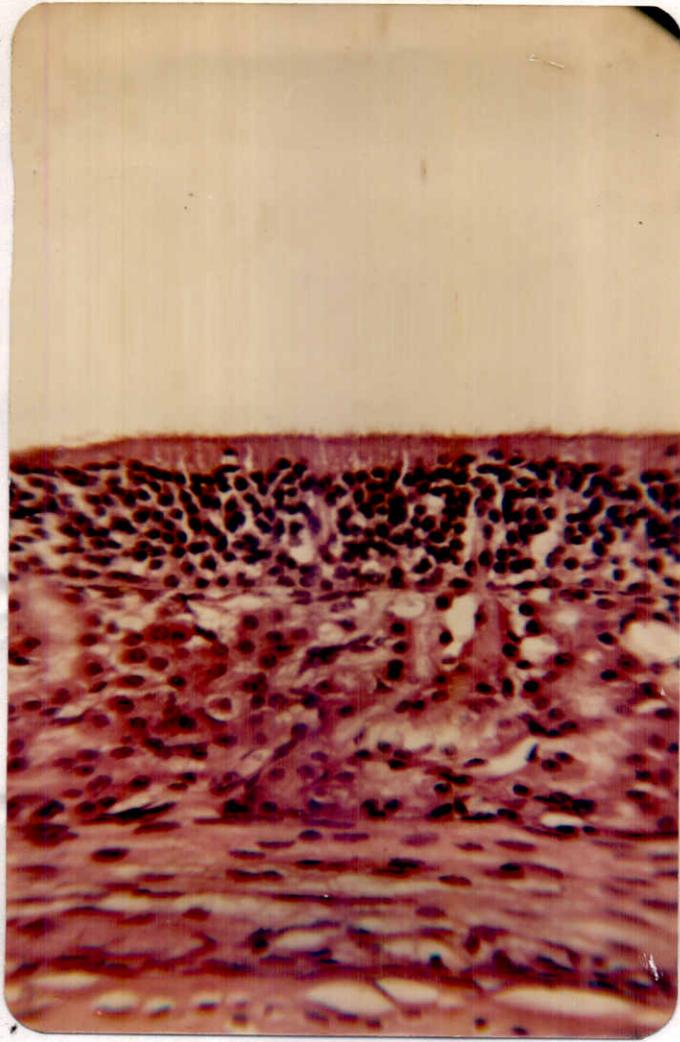


Fig. (22): A section of the nasal mucosa of a control rat showing the covering pseudostratified columnar epithelium with underlying subepithelial glands (H & E X 250).

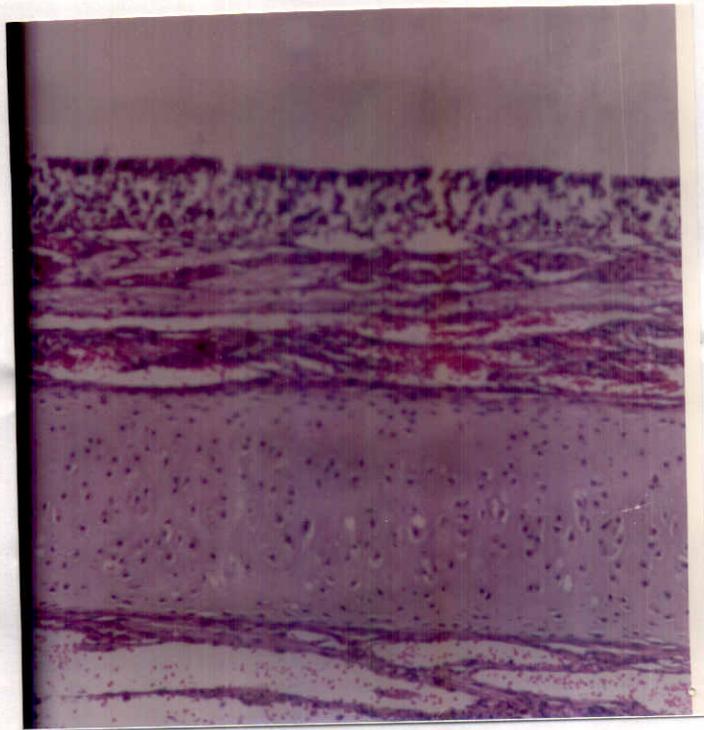


Fig. (23): A section of the nasal mucosa and underlying cartilage of the septum showing marked congestion of the nasal mucosa (H & E X 100).

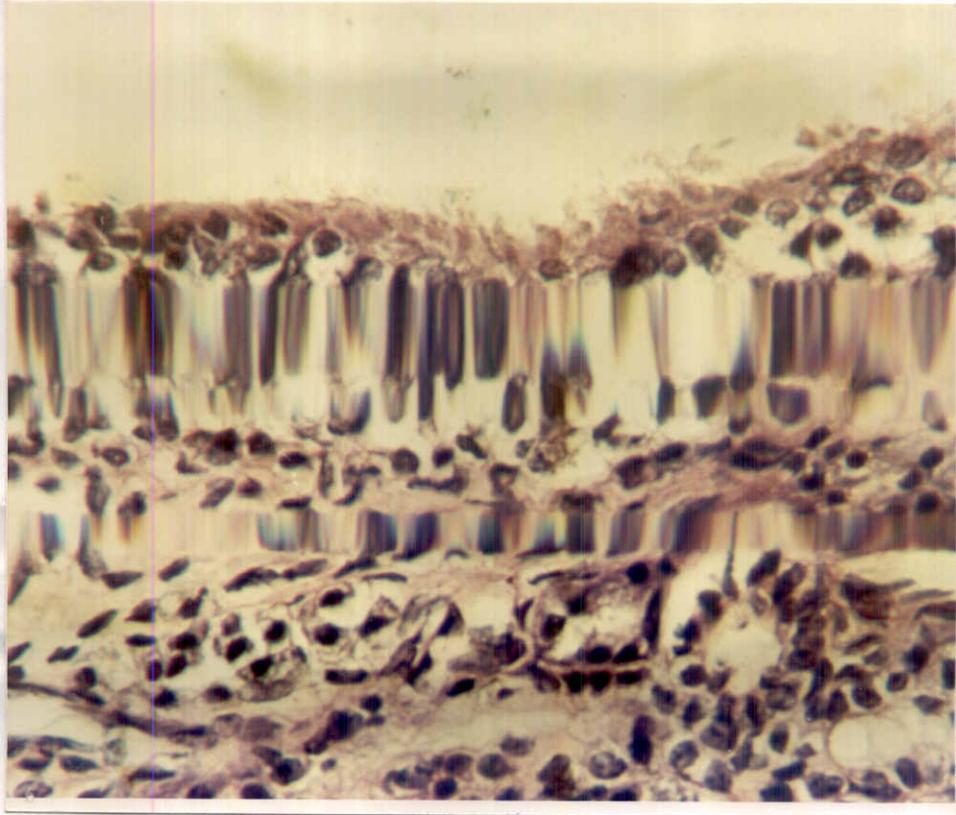


Fig. (26): A section of the nasal mucosa showing a mucosal lining epithelium composed of ciliated cells with prominent goblet cells (H & E X 400).

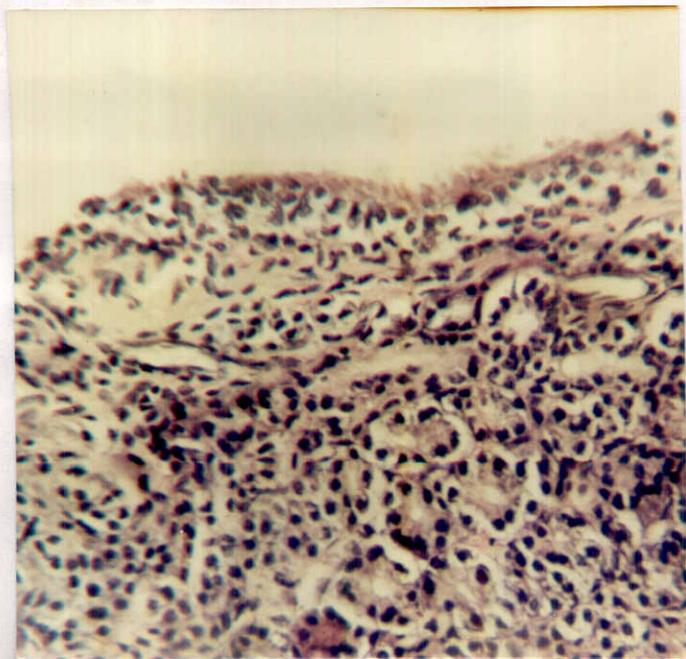


Fig. (27): A section of the nasal mucosa showing prominent glandular component (H & E X 250).

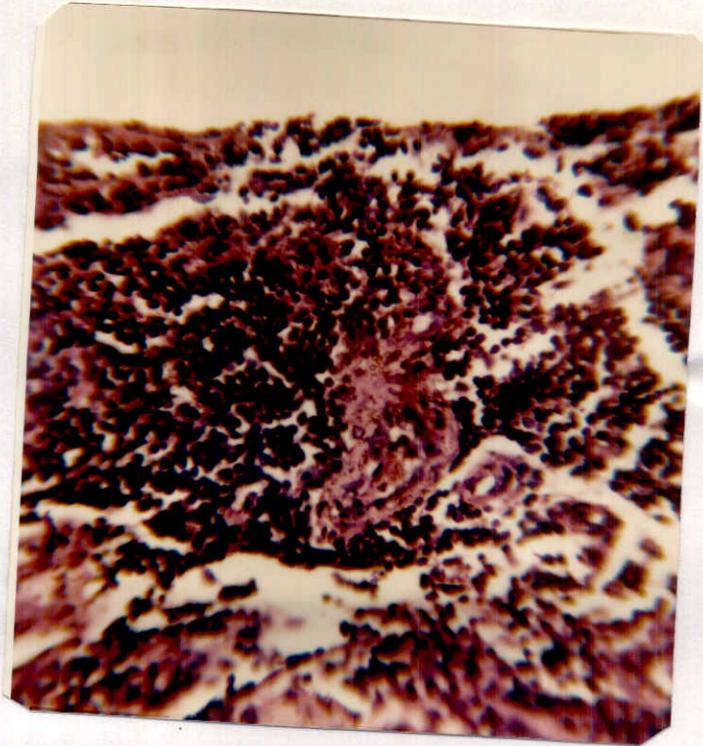


Fig. (28): A section of the nasal mucosa showing intense inflammatory round cell infiltration (H & E X 250).



Fig. (29): A section of the nasal mucosa showing absence of cilia from the surface epithelium associated vascular congestion is also seen (H & E X 250).

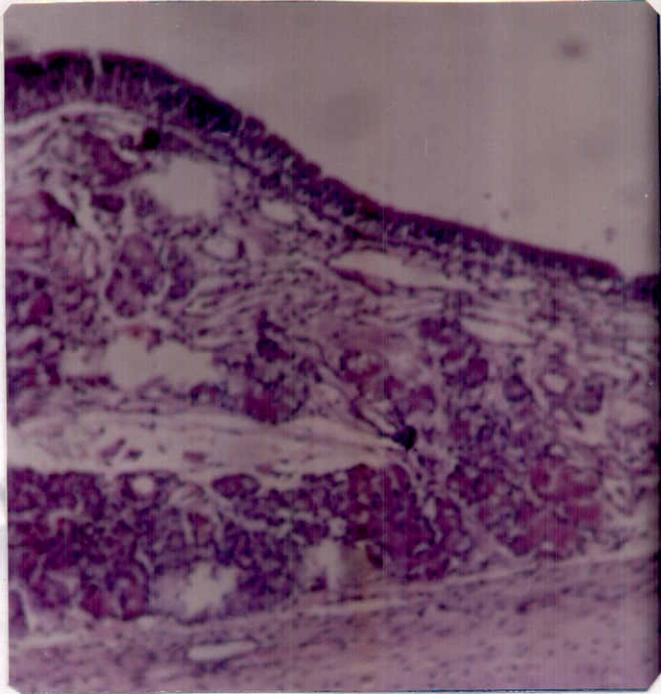


Fig. (30): A section of the nasal mucosa showing marked thickening of the mucosa by vascular congestion, oedema and glandular proliferation (H & E X 100).

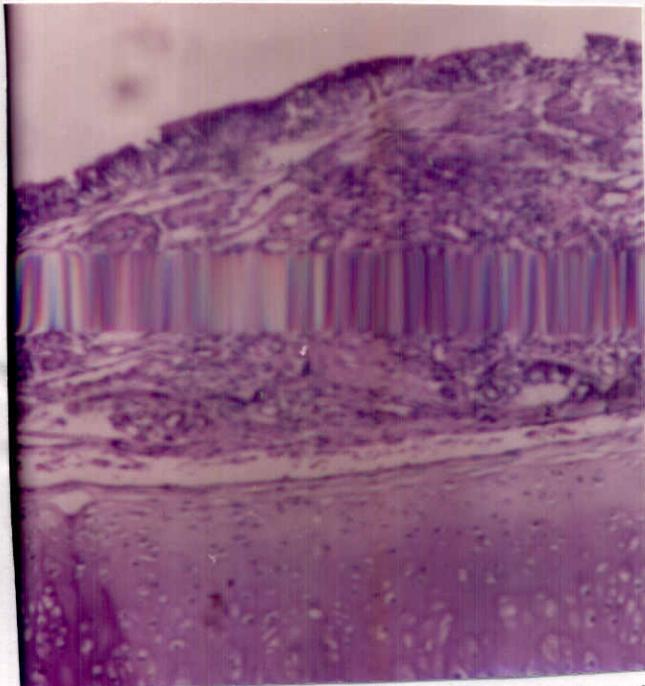


Fig. (31): A section of the nasal mucosa showing increased mucosal thickness by marked glandular proliferation (H & E X 100).

The Middle Ear Mucosa

The Control Ears:

The epithelium covering the wall of the bulla tympanicum was found to consist of flat squamous cells separated from bone by a layer of fibrous tissue with capillaries. The thickness of the subepithelial layer varies greatly from a very thin layer in most areas to a relatively thick layer of fibrous tissue in other areas (Fig. 33 and 34). No specimen showed inflammatory cellular infiltration, squamous metaplasia or venous congestion. On myringotomy, no one of the control animals showed the presence of fluid in the middle ear cavity.

Operated Animals:

* The changes of middle ear mucosa following unilateral nostril closure: (Group I)

Examination of the ears at the same side of the nostrils left open (the left side) showed a completely normal middle ear mucosa in all subgroups of group I.

After One Week:

Examination of the ears at the side of the closed nostrils showed normal middle ear mucosa in all rats subjected to unilateral closure for one week. So no changes were found bilaterally in the middle ear of all rats in this subgroup.

After Two Weeks:

In rats subjected to unilateral nostril closure for two weeks, 2 out of 18 rats (11.1%) showed changes of the middle ear mucosa at the same side of closed nostrils in the form of vascular dilatation and oedema (Fig. 38) but no inflammatory cellular infiltration or squamous metaplasia were noted. Also no fluid accumulation in the middle ear cavity of both animals was noted.

In these two animals the changes of the nasal mucosa on the closed side seen anteriorly as well as posteriorly, were in the form of increase mucosal thickness, venous congestion, increased subepithelial glands and goblet cells but no inflammatory cellular infiltration was noted.

After One Month:

Three out 18 rats (16.6%) showed changes of the middle ear mucosa at the side related to the closed nostril. In two of these three rats the changes of the middle ear mucosa were in the form of heavy inflammatory cellular infiltration (Fig. 37) and accumulation of mucoid fluid in the middle ear. Examination of the nasal mucosa of these 2 rats revealed marked inflammatory cellular infiltration of the same side with ciliary destruction, increase mucosal thickness and increased subepithelial glands and these changes were noted anteriorly as well as posteriorly. The middle ear mucosa of the third rat showed marked vascular dilatation, oedema of the lamina propria, squamous metaplasia but no inflammatory cellular infiltration or fluid accumulation in the middle ear cavity were observed. The nasal mucosa of this rat showed increased epithelial thickness, increased subepithelial glands and marked venous congestion.

After Two Months:

In the rats subjected to unilateral nostril closure for two months, the middle ear mucosa showed no changes in all rats.

After Three Months:

In the rats subjected to unilateral nostril closure for three months, the middle ear mucosa showed no changes in all rats.

* The changes of middle ear mucosa in rats subjected to bilateral nostril closure: (Group II)

After Three Days:

After 3 days of bilateral nostril closure no changes of the middle ear mucosa of both sides were observed in the examined 8 rats.

After Five Days:

In the rats subjected to bilateral nostril closure for 5 days, 2 out of 8 rats (25%) showed changes of the middle ear mucosa in the form of dilated vessels and oedema of the lamina propria. These changes were observed in both sides.

After Seven Days:

Two out of 8 rats (25%) showed marked vascular dilatation, oedema of the lamina propria and sparsely distributed areas of squamous metaplasia and these changes were also noted similarly on both sides (Fig. 38).

After Nine Days:

Two out of 6 rats showed middle ear mucosal changes. In one of these 2 rats markedly dilated vessels with oedema of the lamina propria and sparsely distributed squamous metaplasia were seen. Examination of the nasal mucosa of this rat showed increased thickness of the epithelium by increased subepithelial glands and marked venous congestion on both sides.

In the other rat there were heavy inflammatory cellular infiltration, vascular congestion and mucoid fluid accumulation in both middle ear cavities. In this rat the nasal mucosa showed bilateral inflammatory cellular infiltration, ciliary destruction and increased subepithelial glands.

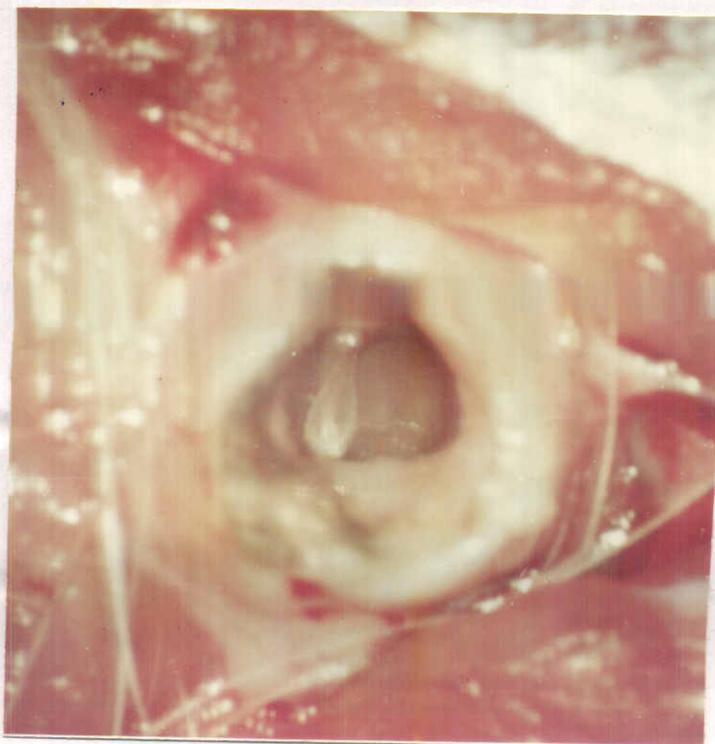


Fig. (32): Photography showing the right drum of the rat with apparent retraction of the segment anterior to the handle of maleus (arrow).

Fig. (33): A section of the middle ear of a control rat showing mature bone covered by a thin flattened epithelium (arrow), (H & E X 250).

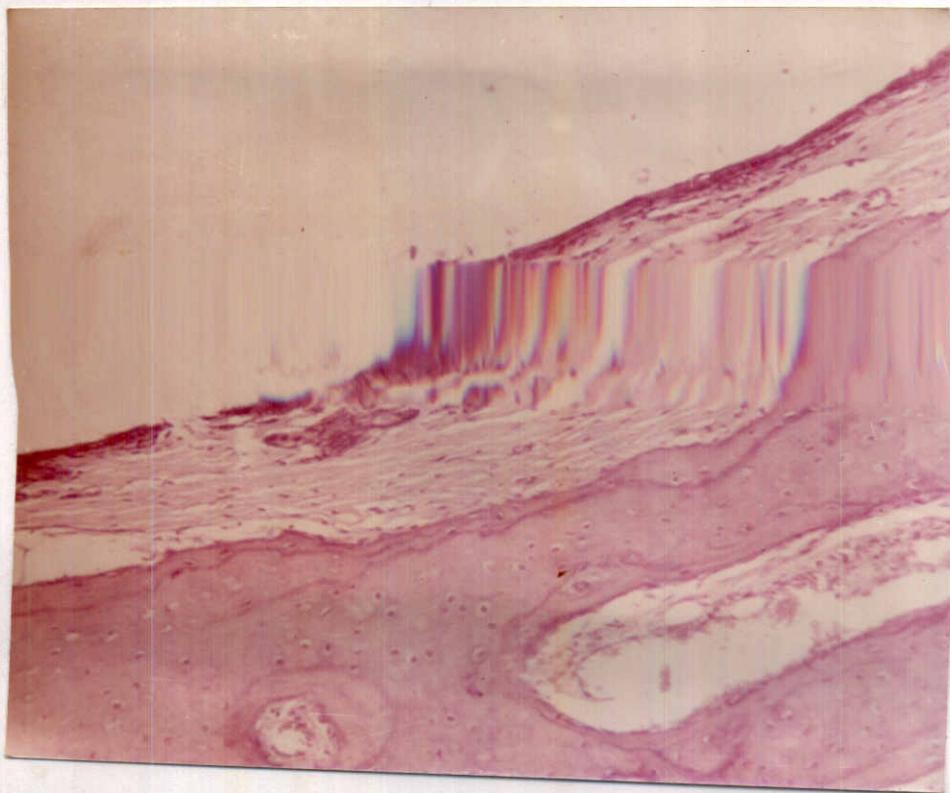


Fig. (34): A section of the middle ear of a control rat showing mature bone covered by a thin flattened epithelium with the underlying lamina propria (arrow), (H & E X 100).

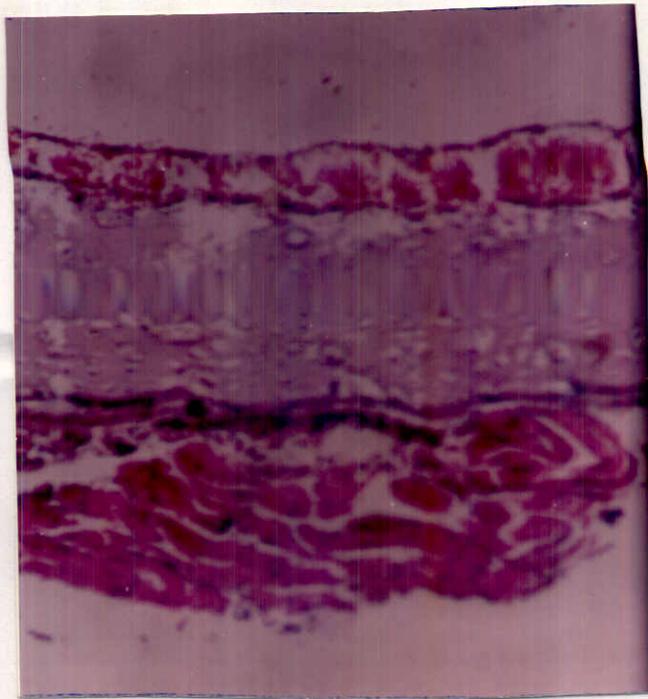


Fig. (35): A section of the middle ear of the rat showing extreme vascular congestion (arrow), (H & E X 100).

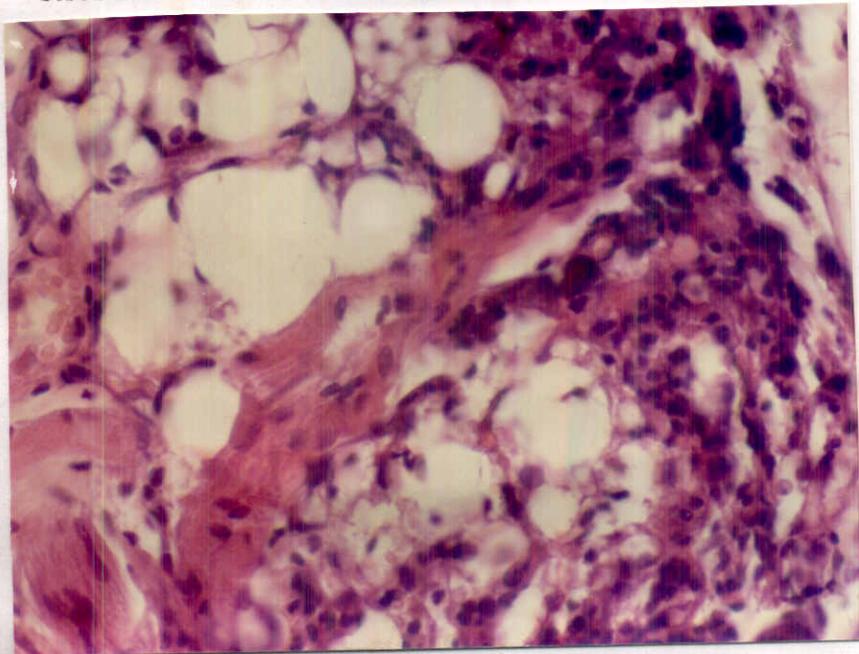


Fig (36): This represents the picture of the middle ear mucosa of a severely inflamed ear. There is heavy inflammatory exudate infiltrating mature fat cells, (H & E X 400).

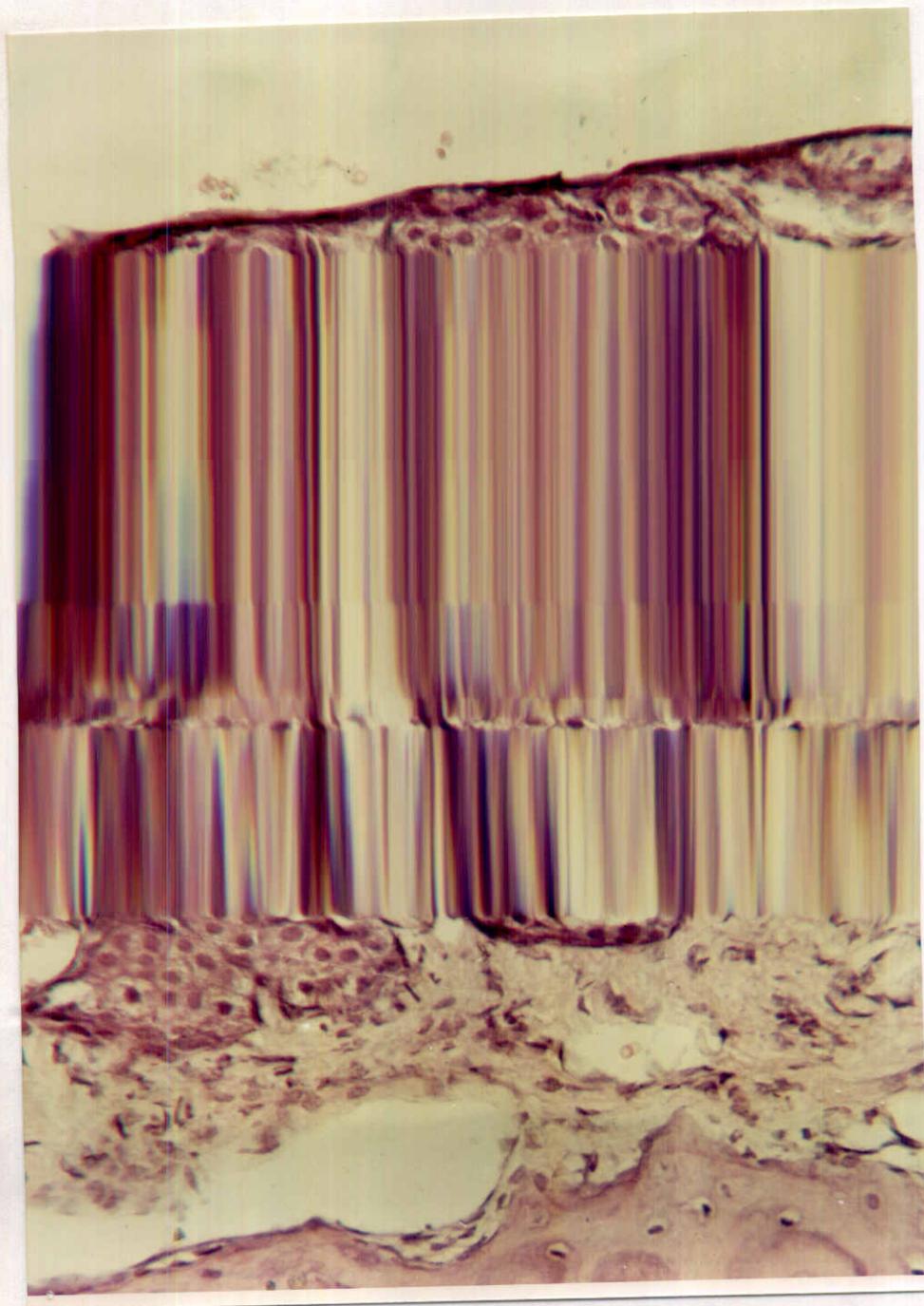


Fig. (37): A section of the middle ear of the rat showing squamous metaplasia of the surface epithelium (H & E X 250).

