

EFFECT OF SMALL DOSES OF X-RAYS ON HYPERTROPHIED TONSILS AND OTHER LYMPHOID STRUCTURES OF THE NASOPHARYNX.*

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In work carried on by us over several years we have extended the original observation of Heinicke¹ on the susceptibility of lymphoid tissue to x-rays and have shown other ways in which the x-rays may be employed as a therapeutic agent. It may be regarded now as established that the lymphoid tissue is more highly susceptible to x-rays than any of the structures of the body, except the sex glands, and that by suitable exposures it is possible to remove almost all of the lymphoid tissue without inducing detectable changes in other organs or tissues.² When the doses of x-rays are properly graded even the total number of polymorphonuclear leucocytes remains unaffected while the lymphocytes fall to a point at which few are seen in the circulating blood.³

The use of x-rays for reducing enlarged lymphoid organs is not new, but in the past the doses employed for the purpose have been large and thus have approached the danger point so closely that it has

* A preliminary report was made of this work before the American Society for Clinical Investigation and published in the Proceedings of the Society (Murphy, Jas. B., *J. Am. Med. Assn.*, 1920, lxxiv, 1738).

¹ Heinicke, H., *Mitt. Grenzgeb. Med. u. Chir.*, 1905, xiv, 21.

² Murphy, Jas. B., *J. Am. Med. Assn.*, 1914, lxii, 1459. Murphy, Jas. B., and Ellis, A. W. M., *J. Exp. Med.*, 1914, xx, 397.

³ Taylor, H. D., Witherbee, W. D., and Murphy, Jas. B., *J. Exp. Med.*, 1919, xxix, 53.

been resorted to only in extreme instances. If, as our work indicates, extensive reduction of lymphoid tissue can be induced by small doses of x-rays, well within the safety limit, there is no reason why x-rays should not be used as a therapeutic agent in a variety of conditions. For obvious reasons the tonsil has been selected for the purpose of testing this point.

Histological examination of the tonsil shows it to have a structure similar to that of other lymphoid glands, with the exception of the fact that it is covered on one side by mucous membrane with crypts dipping down from the surface. These crypts have been described as natural test-tubes for the growth of bacteria. Whether or not the presence of pathogenic organisms in the crypts is the source of hypertrophy of the organ or whether the hypertrophy arises from another set of conditions is a moot point. It is, however, agreed that enlarged tonsils with resultant poorly drained crypts have a pathological significance.

In addition to the enlargement of the tonsil, other lymphoid deposits showing hypertrophy occur through the mucous membrane of the pillars of the fauces and as masses back of the posterior pillars. These structures also become pathologically altered in much the same way as the tonsil. They are not subject to surgical removal as is the tonsil but since they are made up of lymphoid cells are subject to influence by x-rays.

The following study was undertaken in order to test the effect of small doses of x-rays on the tonsil and other lymphoid deposits of the nasopharynx.

Technique.

The individuals to be treated are placed on a table with the head tilted so that the axis of the x-rays may pass under the angle of the jaw into the region of the tonsil. The area exposed on each side of the neck is about 3 inches square, the surrounding surface being covered with heavy sheet lead. The factors governing the dose of x-rays to each area were as follows: 8 inch spark-gap measured between points, 5 milliamperes, 10 inches distance from the target to the highest point of skin exposed; the time varies from 3 to 7 minutes, depending on the age of the individual, and the x-rays were filtered through 3 mm. of aluminum. The approximate value of this dose

is from one to one and three-quarters skin units. After an interval of a few weeks this treatment may if necessary be repeated with safety.⁴ To insure immobility in young children a special board has been used with retaining straps and the child's head secured by means of a gauze bandage.

When excessive adenoid tissue was present a third area was exposed; namely, the back of the neck, just below the posterior occipital region with the head tilted forward. But this site of entry for the x-rays is less favorable, as will be indicated later in this paper.

Material.

This report is based on the study of 46 individuals ranging in age from $3\frac{1}{2}$ to 45 years and observed 1 month or longer after treatment. About 40 other individuals were treated, but as they did not return for examination they have not been included. The condition of the tonsils was noted in each individual and a drawing showing the size made by an artist independent of the examining physician. The state of the tonsils on first examination varied from that of simple hypertrophy to the enlarged organ with ragged surface and deep crypts containing exudate, or the small pathologically altered tonsil associated with symptoms of systemic disease. No individuals were treated at a time when the throat showed signs of acute inflammation.

The histories of eleven selected typical cases will be given and drawings of some of these, showing the progressive changes in the throat.

Case A.—J. L. L., white, male; age 19 years (Fig. 1).

Mar. 15, 1920. Throat: The tonsils, small and buried, the left larger than the right, ragged in appearance; numerous crypts containing exudate. Lymphoid

⁴In a later study Witherbee has recommended the use of fractional doses, four or more if necessary, treatments being given at 2 week intervals (Witherbee, W. D., *Am. J. Roentgenol.*, 1921, viii, 25). The factors of this dose are, 7 inch spark-gap measured between points, 5 milliamperes, 10 inches distance, time of exposure 3 minutes and 18 seconds; filtered through 3 mm. of aluminum. The principal advantage of this method is that it makes the treatment more flexible and the individual may be given more nearly the amount of x-rays necessary to induce the desired result.

tissue behind pillars increased in amount; large amount of adenoid tissue. Enlarged cervical lymph nodes. Bacteriological examination:⁵ Right tonsil 50, left tonsil 150 colonies of hemolytic streptococci; vault none. X-rays: Three areas, right and left sides of neck and posterior occipital region, exposed to filtered x-rays; spark-gap 8 inches, milliamperes 5, time 6 minutes, filtered through 3 mm. of aluminum.

Mar. 22. Tonsil tissue markedly reduced and glazed and pale in appearance; lymphoid tissue behind pillars pale and smooth. Bacteriological examination: Right tonsil 50, left 150, and vault 50 colonies of hemolytic streptococci.

Apr. 5. Tonsil pale; edges of crypts inverted; no exudate can be pressed from tonsil. Adenoids considerably reduced; smooth and pale. Bacteriological examination: Right tonsil 100, left tonsil 50, and vault 150 colonies of hemolytic streptococci.

Apr. 26. Little visible tonsil tissue, of smooth appearance; no exudate; adenoid tissue small in amount, smooth and regular. Bacteriological examination: No hemolytic streptococci found.

Case B.—E. S., white, male; age 26 years (Fig. 2).

Dec. 10, 1919. Throat: Medium sized tonsils with deep crypts full of exudate; ragged inflamed surface. X-rays: Two areas, right and left side of neck, exposed to x-rays; spark-gap 8 inches, milliamperes 5, distance 10 inches, time 6 minutes, filtered through 3 mm. of aluminum.

Mar. 4, 1920. Tonsil shows marked shrinkage; some exudate present. X-rays: Two areas, right and left side of neck, exposed to x-rays in same dosage as above.

Apr. 4. Tonsils small; smooth surface; no exudate.

Mar. 5, 1921. Tonsils small with smooth surface; no exudate.

Case C.—H. W., white, male; age 14 years.

Mar. 17, 1920. Throat: Tonsils very large, buried; irregular surface; numerous crypts with yellowish exudate. Mass of lymphoid tissue back of pillars. Adenoid tissue, large mass covering surface of vault and fossa. Bacteriological examination: Right tonsil no colonies, left 50, and vault 50 colonies of hemolytic streptococci. X-rays: Three areas, right and left side of neck and posterior occipital region, exposed to x-rays; spark-gap 8 inches, milliamperes 5, distance 10 inches, time 6 minutes, filtered through 3 mm. of aluminum.

Mar. 24. Tonsils show decided reduction in size; pale, smooth surface; on pressure some whitish secretion. Adenoid tissue considerably reduced and of smooth, clean appearance. Bacteriological examination: Tonsils no colonies, vault 50 colonies of hemolytic streptococci.

Mar. 31. Tonsils show further reduction in size; smooth and pale; no exudate on pressure. Adenoid tissue pale, smooth, and clean; more normal in appearance. Bacteriological examination: Tonsils and vault show no hemolytic organisms.

Apr. 7. Improvement continues. Lymphoid tissue along posterior pillars has entirely disappeared.

⁵ It is obvious that the number of colonies is roughly indicative only, as the quantity of material inoculated and part of organ touched with the loop are not subject to accurate control.

June 14. Tonsils flat; pale smooth surface; adjacent mucous membrane pale; edges of crypts inverted and crypts show retraction. Adenoid mass materially reduced. Bacteriological examination: No cultures taken.

Case D.—S. A., white, male; age 31 years.

Apr. 7, 1920. Throat: Tonsils moderately enlarged, buried; numerous crypts; purulent fluid on pressure. Marked hypertrophy of lymphoid tissue along posterior pillars. No adenoid tissue. Bacteriological examination: Right tonsil 200, left tonsil 200, and vault 200 colonies of hemolytic streptococci. X-rays: Three areas, right and left side of neck and posterior occipital region, exposed to x-rays. Spark-gap 8 inches, milliamperes 5, distance 10 inches, time 6 minutes, filtered through 3 mm. of aluminum.

Apr. 12. Tonsils show some reduction; pale and smooth; very little exudate on pressure. Marked reduction in lymphoid tissue on posterior pillars. Bacteriological examination: Right tonsil 150, left tonsil 200, and vault no colonies of hemolytic streptococci.

Apr. 19. Tonsils markedly reduced, smooth, pale, normal in appearance; less exudate on deep pressure. Further reduction in amount of lymphoid tissue on pillars. Bacteriological examination: Right tonsil 50 colonies, left tonsil no colonies, and vault 50 colonies of hemolytic streptococci.

May 10. Tonsils further reduced; mucous membrane of tonsil and pillars smooth and pale; edges of crypts rounded; small amount of exudate on deep pressure. Lymphoid deposit on pillars has practically disappeared. Bacteriological examination: No hemolytic streptococci found.

Case E.—J. V. K., white, male; age 15 years (Fig. 3).

Mar. 31, 1920. Throat: Tonsils large with ragged, irregular surface; numerous crypts with exudate. Large irregular mass of adenoid tissue. Bacteriological examination: Right tonsil 150 colonies of hemolytic staphylococci, 50 colonies of hemolytic streptococci; left tonsil 50 colonies of hemolytic streptococci; vault 100 colonies of hemolytic staphylococci. X-rays: Three areas, right and left side of neck and posterior occipital region, exposed to x-rays; spark-gap 8 inches, milliamperes 5, distance 10 inches, time 6 minutes, filtered through 3 mm. of aluminum.

Apr. 7. Tonsils slightly reduced; less ragged in appearance. Adenoids show some reduction. Vault contains mucopurulent discharge. Bacteriological examination: Right tonsil 100, left 50, and vault no colonies of hemolytic streptococci.

Apr. 14. Tonsils markedly reduced; surface irregular, ragged, and congested. Adenoid tissue reduced; smoother surface. Bacteriological examination: No hemolytic organisms found.

Apr. 21. Tonsils show still further reduction; surface smooth; edges of crypts inverted. Adenoid tissue markedly reduced; smooth pale surface. Bacteriological examination: No hemolytic organisms found.

Apr. 26. Tonsils flat; pale, smooth, clean surface; edges of crypts round and inverted. Bacteriological examination: No hemolytic organisms found.

May 24. Tonsils normal in appearance. Adenoid mass reduced in size.

Sept. 29. Tonsils very small; smooth, pale surface. Adenoids greatly reduced and normal in appearance.

Case F.—S. V. M., white, male; age 10 years.

Mar. 24, 1920. Throat: Tonsils large, partly buried; irregular, ragged surface; numerous crypts filled with thick yellow exudate. Lymphoid tissue behind pillars markedly hypertrophied. Large irregular mass of adenoid tissue covered with purulent exudate. Bacteriological examination: Right tonsil 200, left tonsil 100, and vault no colonies of hemolytic streptococci. X-rays: Three areas, right and left side of neck and posterior occipital region, exposed to x-rays; spark-gap 8 inches, milliamperes 5, distance 10 inches, time 6 minutes, filtered through 3 mm. of aluminum.

Mar. 31. Tonsils reduced in size; edges of crypts inverted; less exudate. Pharynx had dull red glazed appearance. Adenoid tissue considerably reduced; pale; less exudate. Bacteriological examination: Right tonsil 50 colonies of hemolytic streptococci, left tonsil and vault no hemolytic organisms.

Apr. 7. Tonsils markedly reduced; some surface secretion; crypts much cleaner. Adenoid tissue still further reduced. Bacteriological examination: No hemolytic organisms found.

Apr. 14. Tonsils very markedly reduced; surface smooth and clean; edges of crypts inverted and smooth; no exudate on deep pressure. Adenoid tissue smooth; normal appearance. Lymphoid tissue back of posterior pillars practically disappeared. Bacteriological examination: No hemolytic organisms found.

Sept. 29. Tonsils show further reduction; normal in appearance; edges of crypts smooth and inverted. Adenoid tissue still present; small amount of exudate on pressure.

Case G.—J. W., white, male; age 17 years (Fig. 4).

Mar. 24, 1920. Throat: Tonsils very large; ragged and congested. Considerable hypertrophy of lymphoid tissue behind posterior pillars. Bacteriological examination: Right tonsil 200, left tonsil 150, and vault 200 colonies of hemolytic streptococci. X-rays: Three areas, right and left side of neck and posterior occipital region, x-rayed; spark-gap 8 inches, milliamperes 5, distance 10 inches, time 6 minutes, filtered through 3 mm. of aluminum.

Mar. 31. Tonsils showed marked reduction; pale and smooth. Bacteriological examination: Right tonsil 100, left tonsil 50, vault 100 colonies of hemolytic streptococci.

Apr. 14. Tonsils show still further reduction; smooth, normal appearance. Lymphoid tissue behind posterior pillars entirely gone. Bacteriological examination: No hemolytic organisms found.

June 28. Tonsils small, smooth, pale; edges of crypts inverted and translucent.

Sept. 13. Tonsils show some further reduction; white bands around edges of inverted crypts; right tonsil shows some cheesy deposits, easily removed on pressure. Bacteriological examination: Right tonsil 50 colonies of hemolytic streptococci, left tonsil and vault no hemolytic organisms.

Feb. 17, 1921. Tonsils small, flat; surface smooth and pale; no exudate. Bacteriological examination: No hemolytic organisms found.

Case H.—J. Z., white, male; age 21 years (Fig. 5).

Mar. 10, 1920. Throat: Tonsils moderately enlarged; ragged surface; numerous crypts. Left tonsil has large fossa filled with purulent exudate. Moderate sized mass of adenoid tissue, irregular, covered with whitish secretion. Bacteriological examination: Right tonsil no hemolytic organisms; left tonsil 50 colonies of hemolytic streptococci and 200 colonies of hemolytic staphylococci; vault 50 colonies of hemolytic streptococci and 50 colonies of hemolytic staphylococci. X-rays: Three areas, right and left side of neck and posterior occipital region, exposed to x-rays; spark-gap 8 inches, milliamperes 5, distance 10 inches, time 6 minutes, filtered through 3 mm. of aluminum.

Mar. 17. Tonsils distinctly reduced; cleaner in appearance. Adenoids cleaner. Bacteriological examination: No hemolytic organisms found.

Mar. 31. Tonsils reduced; still some exudate. Adenoid tissue reduced, pale; less exudate.

Apr. 28. Tonsils show marked reduction; smooth, pale surface; crypts clean; no exudate on deep pressure.

June 14. Tonsils show still further reduction; no exudate from right tonsil, small amount from left on deep pressure. Adenoids possibly reduced.

Sept. 13. Tonsils small, smooth, pale; on deep pressure still some exudate; edges of crypts markedly inverted. Adenoid tissue still present.

Mar. 11, 1921. Tonsils small; normal in appearance.

Case I.—V. S., white, male; age 14 years (Fig. 6).

Mar. 3, 1920. Throat: Tonsils large, ragged; numerous crypts full of pus. Large mass of lymphoid tissue behind posterior pillars. Large mass of adenoid tissue. Bacteriological examination: Right tonsil 100 colonies of hemolytic streptococci and 50 colonies of hemolytic staphylococci; left tonsil 50 each of hemolytic streptococci and staphylococci; vault 50 colonies of hemolytic streptococci and 150 of hemolytic staphylococci. X-rays: Two areas, right and left side of neck, exposed to x-rays; spark-gap 8 inches, milliamperes 5, distance 10 inches, time 7 minutes, filtered through 3 mm. of aluminum.

Mar. 10. Tonsils reduced in size; smooth surface; less exudate on pressure. Lymphoid masses behind posterior pillars markedly reduced; smooth glazed appearance. Bacteriological examination: Right tonsil 50 colonies of hemolytic streptococci, left tonsil and vault no hemolytic organisms found.

Mar. 17. Tonsils still further reduced; pale, clean. Bacteriological examination: No hemolytic organisms found.

Mar. 24. Tonsils smaller; smooth surface. Further reduction in lymphoid tissue back of pillars. Bacteriological examination: No hemolytic organisms found.

Apr. 28. Tonsils show marked reduction in size; pale and smooth; no injection of mucous surfaces; no exudate on deep pressure; edges of crypts smooth. Lymphoid tissue behind posterior pillars practically disappeared. Adenoid mass reduced. Bacteriological examination: No hemolytic organisms found.

Sept. 13. Tonsils small and normal in appearance; no exudate on deep pressure; edges of crypts smooth and inverted; mucous surfaces show no injection. Lymphoid deposits back of pillars practically gone. Adenoids reduced but still large.

Case J.—E. C., white, male; age 16 years.

Mar. 22, 1920. Throat: Tonsils large; numerous crypts filled with yellowish exudate; large amount of cheesy material on pressure. Hypertrophy of lymphoid tissue on posterior pillars. Large irregular mass of adenoid tissue covered with yellowish exudate. Bacteriological examination: Right tonsil 200, left 150, and vault 150 colonies of hemolytic streptococci. X-rays: Two areas, right and left side of neck, exposed to x-rays; spark-gap 8 inches, milliamperes 5, distance 10 inches, time 6 minutes, filtered through 3 mm. of aluminum.

Mar. 29. Tonsils considerably reduced; smooth and pale; no exudate on pressure. Adenoid tissue considerably reduced. Bacteriological examination: Right tonsil 200, left 150, and vault 150 colonies of hemolytic streptococci.

Apr. 5. Tonsils further reduced; pale and smooth; edges of crypts smooth; slight exudate on pressure. Adenoids markedly reduced; pale, smooth, and clean. Bacteriological examination: Right tonsil 50, left 50, and vault no colonies of hemolytic streptococci.

Apr. 14. Tonsils and adenoids markedly reduced; pale and smooth. Bacteriological examination: No hemolytic organisms found.

May 10. Tonsils small; normal in appearance; mucous surfaces pale; edges of crypts rounded and smooth; no exudate on deep pressure. Lymphoid tissue on posterior pillars has practically disappeared. Adenoid mass considerably reduced in size.

June 14. Tonsils normal in appearance. Adenoids very small, pale, smooth mass.

Sept. 29. Tonsils and adenoids small and normal in appearance; surface smooth; no exudate.

Case K.—J. F., white, male; age 16 years.

Mar. 8, 1920. Throat: Tonsils large, ragged; numerous crypts. Large mass of adenoid tissue. Enlargement of cervical glands. Bacteriological examination: Right tonsil 100, and left tonsil 50 colonies of hemolytic streptococci. X-rays: Two areas, right and left side of neck, exposed to x-rays; spark-gap 8 inches, milliamperes 5, distance 10 inches, time 7 minutes, filtered through 3 mm. of aluminum.

Mar. 15. Tonsils reduced; smooth, glazed surface. Adenoids considerably reduced; smooth and glazed. Bacteriological examination: Right tonsil 100, left tonsil 150, and vault no colonies of hemolytic streptococci.

Mar. 29. Tonsils further reduced; pale and smooth. Adenoids also reduced; pale and smooth. Bacteriological examination: No hemolytic organisms found.

Apr. 5. Right tonsil more reduced than left; surface pale and smooth. Adenoid mass pale, clean.

Apr. 12. Both tonsils further reduced; crypts inverted. Adenoid tissue considerably reduced. Bacteriological examination: Right tonsil 50 colonies of hemolytic streptococci, left tonsil and vault no hemolytic organisms.

May 10. Tonsils markedly reduced; surface normal; edges of crypts rounded and inverted; on deep pressure still slight amount of exudate. Lymphoid tissue behind posterior pillars completely disappeared. Adenoid tissue reduced but still large. Enlarged cervical glands somewhat smaller. Bacteriological examination: Right tonsil 5 colonies of hemolytic streptococci, left tonsil and vault no hemolytic organisms.

Sept. 29. Tonsils markedly reduced; normal in appearance; edges of crypts inverted, pale; no exudate. Adenoid tissue still present.

Table I shows the class of cases which have been treated with x-rays and the result of this treatment.

In general it may be said that the reduction in size of the tonsils and other lymphoid deposits in and behind the pillars of the fauces becomes clearly evident about 2 weeks after treatment and increases for 1 to 2 months. As the tonsil shrinks the crypts open and drain, and finally the edges become inverted and the surface grows smooth and healthy in appearance. The small lymphoid deposits in the pillars and the larger accumulation frequently present behind the posterior pillars of the fauces disappear promptly after the treatment and at the same time the injection of the vessels subsides.

The adenoid tissue is, as expected in view of the portal of entry used for the x-rays, not so uniformly reduced as the tonsils. This particular aspect of the problem of reducing excessive lymphoid tissue in the nasopharynx through x-rays is one to which in the near future especial attention will need to be given.

Bacteriological Examination.

Cultures were taken from the throats of 40 of the 46 individuals before and at intervals after treatment. The material for culturing was obtained from the crypts of the right and left tonsils, by means of a platinum wire about 3 inches long at the end of which was a small loop 2 mm. in diameter, bent at a right angle to the main piece of wire. The tongue was pressed down firmly with a tongue depressor, and the wire introduced into the crypt of the tonsil with a "stab and twist" motion. Caution was used to avoid contamination from

TABLE I.

Individual No.	Age.	Sex.	Tonsils.				Adenoids.		
			Size before treatment.	Condition.	Length of time under observation after treatment. <i>mos.</i>	Size at last examination.	Condition after treatment.	Size and condition before treatment.	Size and condition after treatment.
1	31 <i>yrs.</i>	M.	+++*	Numerous crypts; mucopurulent exudate; considerable lymphoid tissue behind pillars.	2	++	Mucous membrane smooth; lymphoid tissue behind pillars almost gone; general appearance normal.	None.	
2	35	M.	+++	Soft, friable; numerous crypts; thin purulent exudate.	1	+	Edge of crypts smooth; normal.	Small.	Some reduction.
3	13	M.	++++	Ragged, inflamed; exudate.	6	++	Smooth, pale; right tonsil still not normal.	Large.	Little affected by treatment.
4	29	M.	++++	Ragged; deep crypts.	4	++	Crypts smooth and shallow; normal appearance.	Large.	Considerable reduction.
5	25	F.	++++	Not markedly abnormal.	3	++	Edges of crypt inverted; normal.	Small.	Reduction.
6	16	M.	++++	Numerous crypts; yellow, cheesy exudate; large mass of lymphoid tissue posterior to pillars.	6	++	Surface normal; no exudate in crypts; lymphoid masses posterior to pillars gone.	Large; covered with exudate.	Marked reduction; normal surface.

7	7	M.	+++++	Ragged; crypts contain mucopurulent exudate.	5	+++	Improvement; tonsils still not normal.		
8	15	F.	+++++	Numerous crypts with purulent exudate.	1½	+++	Normal appearance; crypts inverted.	Large.	Reduction.
9	30	F.	+++	Ragged, inflamed; numerous crypts; exudate.	<i>wks.</i> 3	++	Clear, normal.	Medium.	Reduction.
10	?	M.	+++	Deep crypts with cheesy exudate; mass behind pillars.	<i>mos.</i> 5	++	Some exudate on deep pressure; surface normal; posterior pillar deposits absent.	Medium.	Reduction.
11	7	F.	+++	Ragged; deposits posterior to pillars.	5	++	Smooth; normal appearance; deposits posterior to pillars gone.	Large.	Marked reduction.
12	6½	F.	+++	Numerous crypts with ragged edges.	5	+	Normal.	Small.	No reduction.
13	15	M.	++++	Ragged, soft, congested.	1	++	Absolutely normal appearance.	Medium.	Marked reduction.
14	16	M.	++++	Numerous crypts; ragged edges; deposit behind pillars.	6½	++	Normal appearance; deposits behind pillars gone.	Large.	No marked reduction.
15	3	M.	++++	Ragged.	1	++	Much improved.	Very large.	Reduction.
16	6	F.	++++	Congested; numerous crypts; ragged; deposits posterior to pillars very large.	5½	+++	Absolutely normal; deposit back of pillars gone.	Medium.	No marked reduction.

* +++++ very much enlarged; ++++ much enlarged; +++ medium enlargement; ++ approximately normal; + small; - not visible.

TABLE I—Continued.

Individual No.	Age, yrs.	Sex.	Tonsils.					Adenoids.	
			Size before treatment.	Condition.	Length of time under observation after treatment.	Size at last examination.	Condition after treatment.	Size and condition before treatment.	Size and condition after treatment.
17	5	M.	++++	Ragged.	nos. 1½	+++	Edges of crypts inverted; smooth surface.	Very large.	No marked reduction.
18	49	M.	++++	Ragged; large deposit back of pillars.	6	++	Normal; posterior pillar deposits greatly reduced.	Large; ragged.	Some reduction; normal appearance.
19	28	F.	++++	Yellow, cheesy exudate; numerous crypts.	2½	+	Normal.	Medium.	Definite reduction.
20	28	F.	++	Ragged; numerous large crypts.	1	+	Normal; surface smoothed out.	Medium; mucopurulent exudate.	Reduction; no exudate.
21	15	M.	++++	Ragged; large crypts.	6	+	Normal; inversion of crypt.	Large; irregular.	Reduction; smooth.
22	35	M.	++++	Inflamed; ragged; numerous crypts; exudate.	1	++	Normal appearance; smooth, clean surface.	Normal appearance; smooth, clean surface.	Some reduction.
23	7	F.	++++	Ragged.	2	+	Normal appearance.	Large, irregular.	Some reduction.
24	6	F.	++++	Ragged; numerous crypts; mucopurulent exudate.	2	++	Smooth, normal surface.	Small.	Reduction.
25	26	M.	++++	Cheesy exudate.	3	+	Perfectly normal.		

26	19	M.	+	Ragged; numerous crypts.	1	-	Normal appearance; crypts free from exudate.	Large.	Great reduction.
27	10	M.	++++	Ragged; purulent exudate in crypts.	6	+	Normal clean surface; crypts inverted.	Large.	Slight reduction.
28	7	M.	+++	Numerous crypts; pale and ragged.	2	++	Normal; crypts inverted.	Large.	No marked reduction.
29	33	M.	+++	Purulent exudate; crypts irregular with cheesy deposit.	10	+	Normal.	Medium.	Reduction.
30	6	F.	++++	Irregular ragged surface; mucous membrane injected.	2	++	Clean; mucous membrane pale.	Large.	No marked reduction.
31	4	F.	+++	Ragged, congested.	2	++	Surface clear.†	None.	Reduction.
32	17	M.	+++	Irregular surface, congested; thick yellow exudate; deposits posterior to pillars.	6	++	Surface pale and clean; normal.	Small.	
33	35	M.	+++	Yellow exudate in crypts; lymphoid tissue back of pillars.	1½	+	Normal appearance.		
34	45	F.	+++	Cheesy exudate.	5	+	Surface clear; one tonsil still has some exudate on deep pressure.		
35	31	M.	+++	Ragged, congested; purulent exudate and cheesy deposits.	1	++	Normal appearance.	None.	
36	14	M.	+++	Crypts contain pus; lymphoid deposits back of pillars.	6	+	Normal appearance; deposits back of pillars reduced.	Large.	Reduction.

† Later had an attack of tonsillitis.

TABLE I—Concluded.

Individual No.	Age.	Sex.	Tonsils.				Adenoids.		
			Size before treatment.	Condition.	Length of time under observation after treatment <i>mos.</i>	Size at last examination.	Condition after treatment.	Size and condition before treatment.	Size and condition after treatment.
37	36	F.	++	Mucopurulent exudate; lymphoid tissue back of pillars.	5	+	Normal.	Small.	No marked reduction.
38	17	M.	++++	Ragged, congested; lymphoid deposit back of pillars.	8	+	Smooth, pale; some exudate on deep pressure; lymphoid deposits gone.	None.	
39	21	F.	+++	Ragged, congested.	3	+	Normal.	None.	
40	30	F.	++++	Not abnormal.	1	+	Normal.	Small.	Little reduction.
41	23	F.	++	Mucopurulent exudate; cheesy deposits.	5	+	Smooth surface, normal appearance.	None.	
42	14	F.	++	Mucopurulent exudate; cheesy deposits; soft and friable.	5	+	Surface pale and normal; some exudate on deep pressure.	Large.	Little reduction.
43	14	M.	++++	Yellowish exudate.	3	+	Normal.	Large.	Reduction.
44	21	M.	++	Cheesy exudate.	1	+	Normal appearance; still some exudate on deep pressure.	Small.	Little reduction.
45	21	M.	++++	Subacute inflammatory condition.	8	+	Normal appearance; small amount of exudate on deep pressure.	Small.	Little reduction.
46	25	M.	+++	Inflamed; covered with mucopurulent exudate.	14	+	Absolutely normal.	None.	

the tonsil surfaces and the saliva. The material, so obtained, was placed on a blood agar plate, and gently spread over the surface with another platinum wire. The plates were then placed in the incubator at 37.5°C. Examinations of the plates and records of the findings were made after 24 and 48 hours of incubation.

Cultures were also taken from the nasopharyngeal vault by means of a very thin, semicircular, platinum wire, at the end of which was a small loop similar to that of the wire used in culturing the crypts of the tonsils. After firmly depressing the tongue, this wire was introduced into the vault directly back of the nose. The examination of the blood agar plates of these cultures was also made after incubating for 24 and 48 hours.

No attempt was made to differentiate the more common organisms usually found in the throat, such as pneumococcus, *Streptococcus viridans*, *Staphylococcus albus*, and *Staphylococcus aureus*. In distinguishing between hemolytic streptococcus and hemolytic staphylococcus, subcultures and stained films were resorted to. When the colony ranged in size from a pin-point to a small pin-head, and the area of hemolysis around the colony was from three to five times greater, streptococcus was usually found. Colonies which were as large as pin-heads or greater in diameter and about which the zone of hemolysis was very slight, appearing as a small halo, were usually staphylococcus.

36 of the 40 individuals showed hemolytic organisms to be present. Of these, seven became negative 1 week after treatment, fourteen after 2 weeks, eight after 3 weeks, and one after 4 weeks, making a total of 30 of the 36 treated cases which became negative. The six which continued to show hemolytic organisms were lost track of before further observations could be made.

Blood Counts.

The results of the x-ray treatment on the white blood cell count were not uniform. The counts were made at irregular intervals after meals and after a walk of several city blocks. When the lymphocytes were reduced in numbers the reduction was slight and of short duration, which would indicate that the systemic effect of the dose used was very slight.

DISCUSSION.

The small series of cases reported here shows the possibility of materially reducing the lymphoid deposits of the nasopharynx by comparatively small doses of x-rays. Animal experiments had shown that it is possible with x-rays to induce any degree of atrophy of the lymphoid tissue without damaging other tissues. In the series of treated individuals, in all but three or four instances one treatment gave an entirely satisfactory result. In two refractory cases a second treatment was followed by the desired degree of atrophy and a clearing up of the pathological condition. It is most probable that the other few individuals who did not respond to the one treatment would have yielded on further exposure to x-rays but unfortunately the observations were discontinued before this point could be determined.

The degree of atrophy to be aimed at is a matter that experience will decide. If a reduction below the normal size and the clearing up of obvious pathological states is sufficient as has been indicated in the majority of the cases treated and observed by us, there seems to be no reason for carrying the treatment beyond this point. In view, however, of the mild nature of the treatment recommended it appears entirely safe to repeat it at suitable intervals so as to secure almost any degree of atrophy that may be desired.

Our original idea in taking up this work was that the excess of lymphoid tissue interfered with the clearing up of local infections of the pharynx. It seems probable, however, that the disappearance of infection of the tonsils and change in bacteriological flora after x-ray treatment are due to the opening up and proper drainage of the crypts which follow atrophy, rather than the actual removal of the excess lymphoid tissue.

Tonsils which have been exposed to the x-rays and not sufficiently reduced in size would in all probability be as amenable to surgical removal as before the x-ray treatment, for we have never seen any evidence of fibrosis in the lymphoid organs of animals after similar treatment. The fibroid tonsil would probably not be reduced materially by x-rays, as fibrous tissue is not appreciably affected by this agent.

SUMMARY.

46 individuals with tonsils both hypertrophied and otherwise pathologically altered and some of whom had in addition adenoid masses and lymphoid deposits posterior to the pillars of the fauces, were given exposures to x-rays. In all but four cases the treatment was followed by marked atrophy of the tonsils and the other lymphoid deposits, attended by an opening and drainage of the tonsillar crypts. As this process progressed the previously enlarged tonsils assumed a smooth and normal appearance and the hemolytic bacteria—streptococci and staphylococci chiefly—which were often present in the affected tonsil disappeared usually within 4 weeks of the treatment.

EXPLANATION OF PLATES.

PLATE 103.

FIG. 1, *a* to *d*. (*a*) Condition of the tonsils before treatment; small and partly buried, with ragged surface and crypts containing exudate. In addition there were deposits behind the posterior pillars. (*b*) 1 week after x-ray treatment, showing reduction, and smoothing out of surface. (*c*) 3 weeks after treatment, with further reduction; no exudate could be expressed from tonsils. (*d*) 6 weeks after treatment. Tonsils not visible till anterior pillar was pulled back; normal in appearance. Hemolytic streptococci were present at the first examination but had disappeared by the 6th week after treatment.

PLATE 104.

FIG. 2, *a* to *f*. (*a*) The tonsils before treatment; medium size, with deep crypts containing exudate; ragged, inflamed surface. (*b*) 8 days after treatment; some reduction. (*c*) 26 days after treatment; tonsils congested and exudate still present. (*d*) 55 days after treatment; tonsils reduced but not normal. (*e*) 1 week after a second x-ray treatment, showing further reduction, and smoothing out of surface. (*f*) 1 year and 1 month after second treatment; tonsils small and normal in appearance.

PLATE 105.

FIG. 3, *a* to *d*. (*a*) Condition of tonsils before treatment; ragged, irregular surface, with crypts containing exudate. (*b*) 2 weeks after x-ray treatment; tonsils markedly reduced; surface irregular and congested. (*c*) 7 weeks and 5 days after treatment; tonsils normal in appearance. (*d*) 6 months after treatment; tonsils very small and normal. Hemolytic streptococci, present on first examination, disappeared after treatment.

PLATE 106.

FIG. 4, *a* to *e*. (*a*) Tonsils before treatment; very large, ragged, and congested. Hypertrophy of lymphoid tissue behind posterior pillars. (*b*) 3 weeks after treatment; tonsils reduced in size. Lymphoid tissue behind posterior pillars entirely atrophied. (*c*) 2 months after treatment; tonsils further reduced; normal in appearance. (*d*) About 6 months after treatment; tonsils further reduced; normal surface; still some exudate on deep pressure. (*e*) 11 months after treatment; tonsils small, flat; no exudate. Hemolytic streptococci disappeared from the throat after treatment.

PLATE 107.

FIG. 5, *a* to *e*. (*a*) Condition of tonsils before x-ray treatment; enlarged; ragged surface; deep crypts, with purulent exudate. (*b*) 7 weeks after treatment; tonsils markedly reduced; smooth, pale; no exudate on deep pressure. (*c*) 14 weeks after treatment; tonsils still further reduced; surface normal; no exudate. (*d*) 6 months after treatment; tonsils small and normal. (*e*) 1 year and 1 month after treatment; tonsils small and normal. Hemolytic streptococci disappeared from the throat by 1st week after treatment.

PLATE 108.

FIG. 6, *a* to *e*. (*a*) Tonsils before x-ray treatment; large, ragged; crypts contain pus. Large mass of lymphoid tissue behind posterior pillars. (*b*) 2 weeks after treatment; tonsils reduced; surface smooth and clean. Mass behind pillars reduced. (*c*) 4 weeks after treatment; tonsils markedly reduced; pale and smooth; no exudate on deep pressure. (*d*) 8 weeks after treatment; small amount of exudate. (*e*) 6 months after treatment; tonsils small, normal in appearance; no exudate on deep pressure. Lymphoid tissue behind pillars practically gone. Hemolytic streptococci disappeared from throat by 2nd week after treatment.

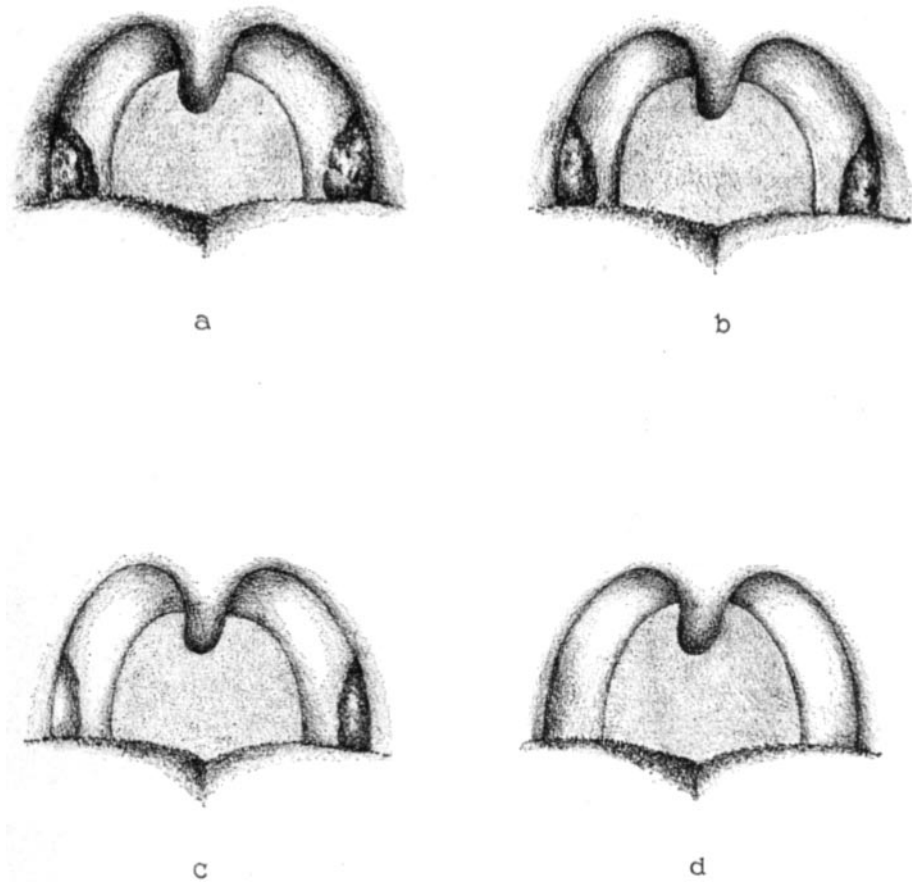


FIG. 1.

(Murphy, Witherbee, Craig, Hussey, and Sturm: Hypertrophied tonsils.)

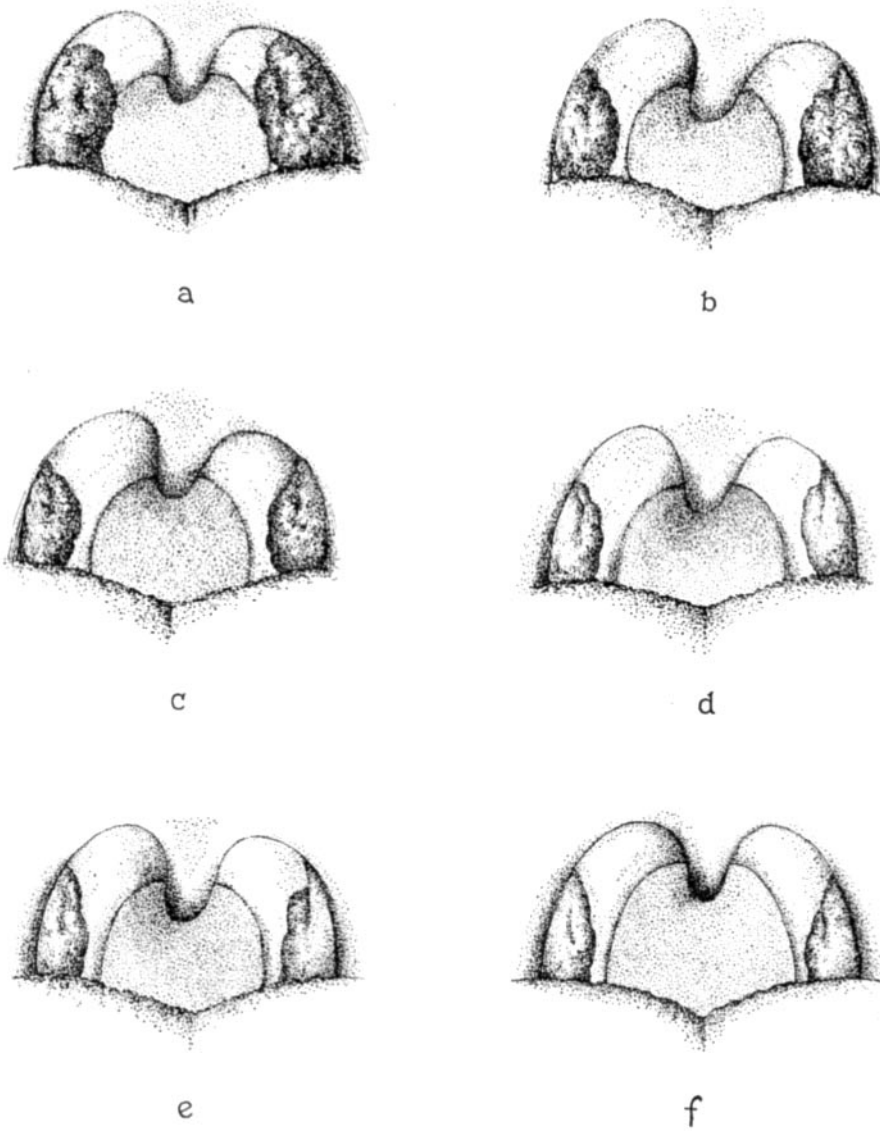


FIG. 2.

(Murphy, Witherbee, Craig, Hussey, and Sturm: Hypertrophied tonsils.)

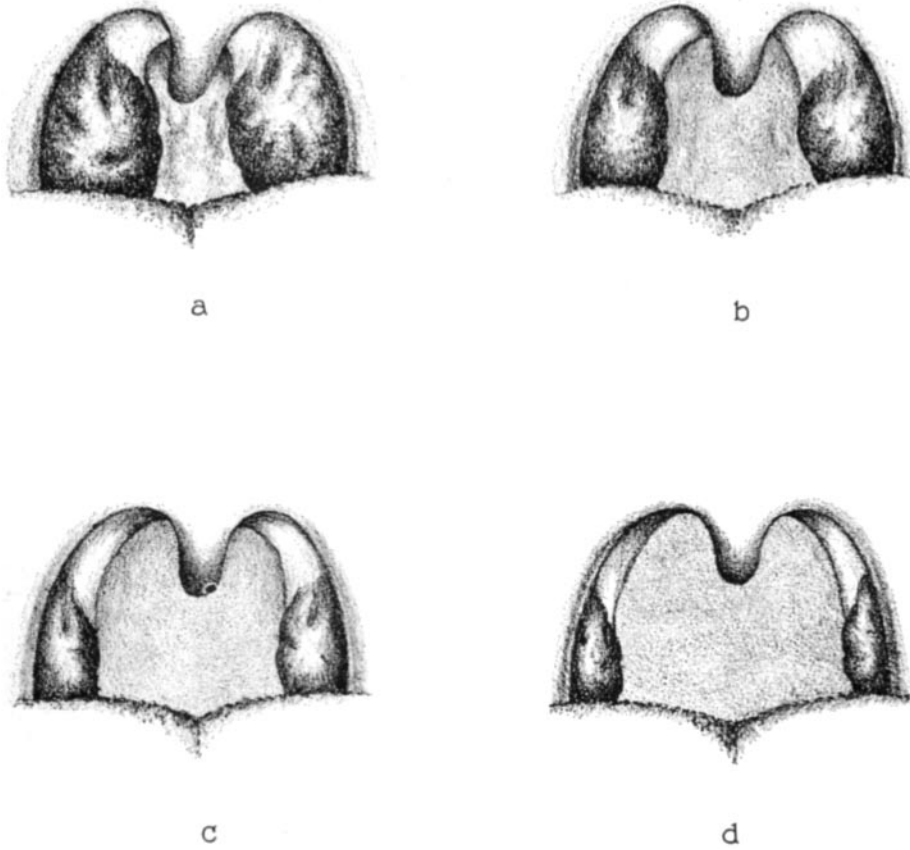


FIG. 3

(Murphy, Witherbee, Craig, Hussey, and Sturm: Hypertrophied tonsils.)

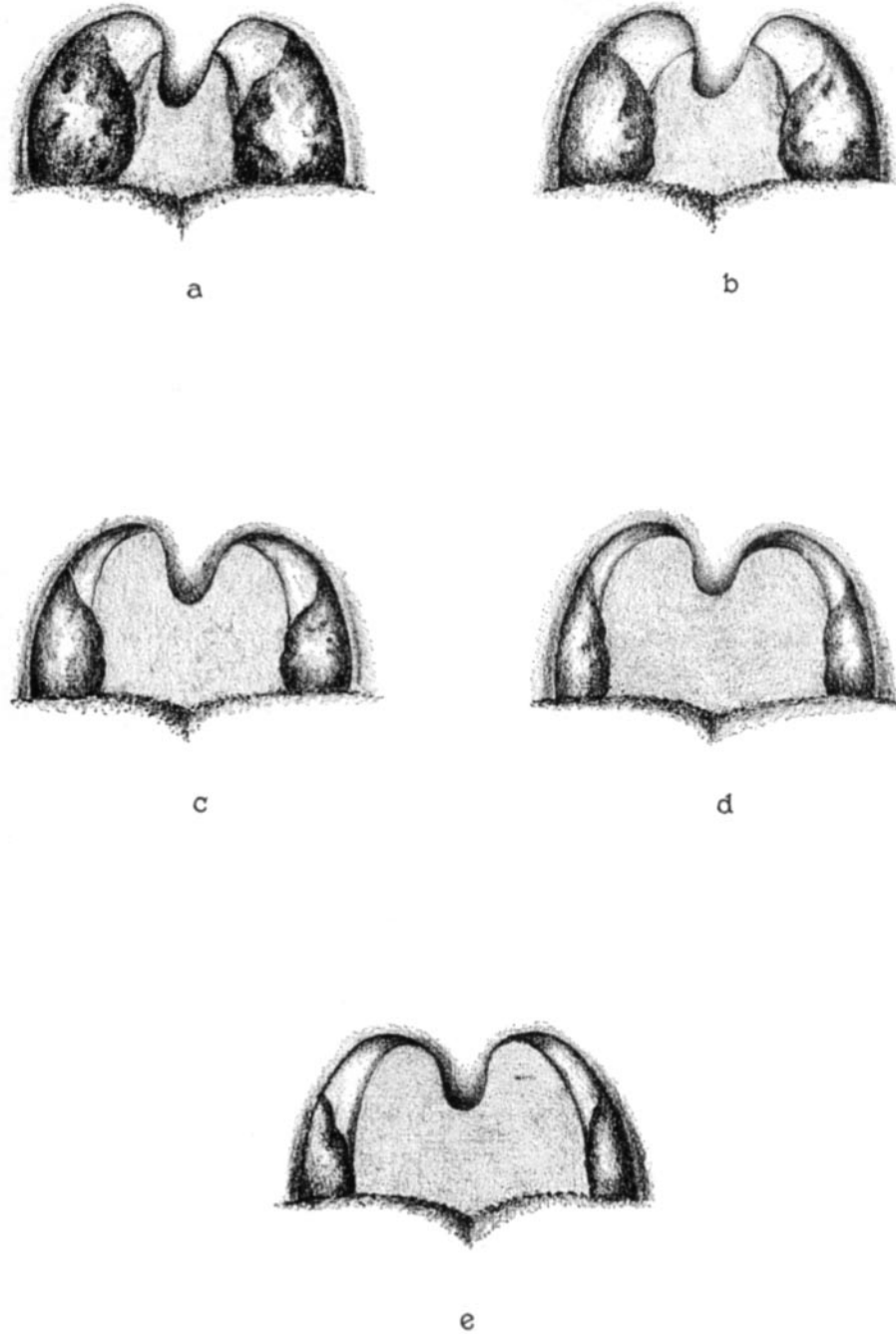


FIG. 4.

(Murphy, Witherbee, Craig, Hussey, and Sturm: Hypertrophied tonsils.)

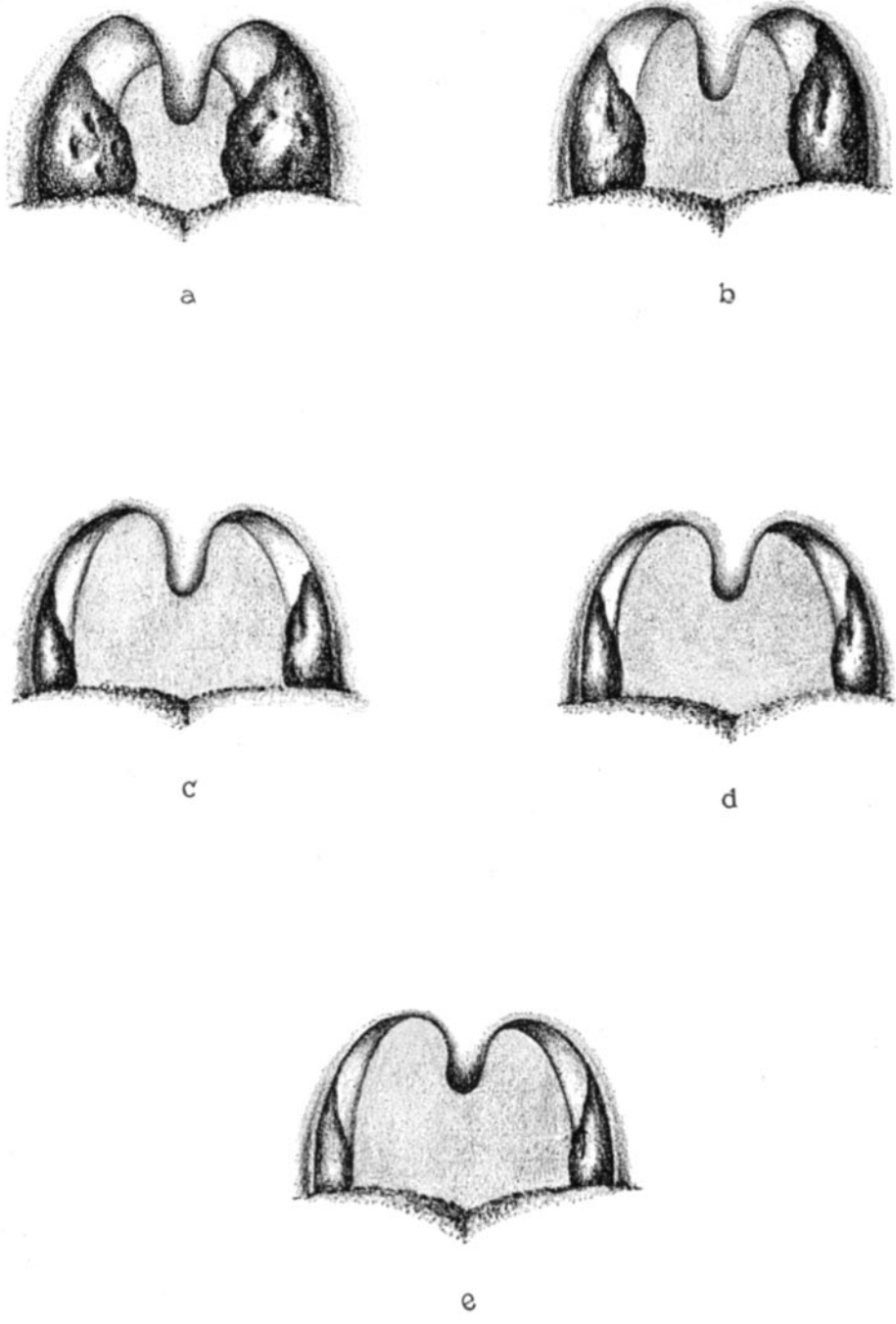
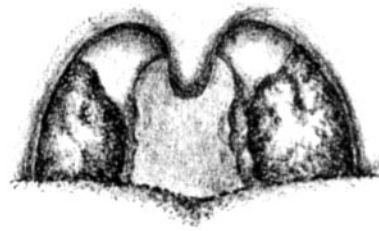


FIG. 5.

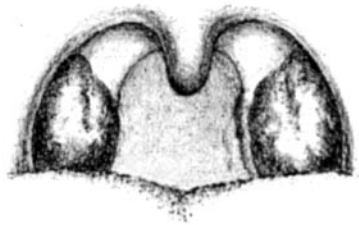
(Murphy, Witherbee, Craig, Hussey, and Sturm: Hypertrophied tonsils.)



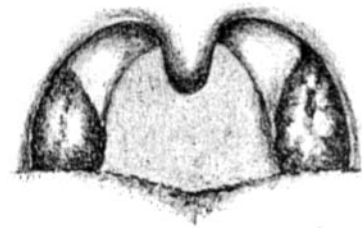
a



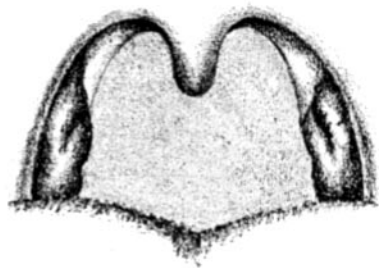
b



c



d



e

FIG. 6.

(Murphy, Witherbee, Craig, Hussey, and Sturm: Hypertrophied tonsils.)