THE BACTERICIDAL ACTION OF GASTRIC JUICE ON B. TUBERCULOSIS.

BY

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DURING the past few years a good deal of attention has been paid to the subject of gastric analysis in normal people. The invention of the Einhorn¹ tube has made this work much more accurate than was possible with the old stomach tube and glass funnel. It is not necessary, however, to refer in detail here to the valuable observations made by Crohn and Reiss,² Rehfuess and Hawk³ in America, and by Ryle⁴ and Bennett⁵ in this country, and by numerous other observers, since most of their work has been done with reference to the chemical side of gastric analysis, with which we are only indirectly concerned. The short series of experiments dealt with in this paper was made with a view to testing the bactericidal power of normal gastric secretion on *B. tuberculosis*.

Technique.

The gastric juice was removed from the stomach with the Einhorn tube in the usual way, at regular intervals for a space of three hours after the test meal given on a fasting stomach, in the early morning. In each case the experiments were made upon persons whose digestive system was believed to be normal, and the test meal given was the oatmeal test recommended in Ryle's paper.⁴ In the first case every sample of gastric juice removed during the period of observation was tested as to its bactericidal power; in the subsequent cases only three samples were tested, care being taken always to use resting juice as one of the samples.

All inoculations into animals were made by one of us (S. R. G.). As the first experiment showed considerable digestion of the tissues at the site of inoculation, and the guinea-pigs died early as a result of absorption of the toxic products of this, we decided in future experiments to inactivate the gastric secretion by neutralization with N/10 NaOH immediately before inoculation.

This procedure was carried out in Experiments II, III, and IV, and was successful in avoiding digestion at the site of inoculation and the consequent toxic absorption.

CASE I.

Healthy adult male clinically free from tuberculosis. Six cubic centimetres of gastric juice from each sample were mixed with approximately 0.5 c.cm. of typical nummular sputum containing tubercle bacilli (that is, about the amount of sputum a patient might readily swallow) and incubated at 37° C. for one and a half hours. The incubated mixtures of gastric juice and sputum were then inoculated into guinea-pigs. The results obtained are tabulated below.

Sample of Gastric Juice.	Starch.	Mucus.	Bile.	Total Acidity in Terms of N/10 NaOH.	Guinea-pig Inoculation.
15 minutes ...	+	—	—	7.5	T.B. +
30 " ...	+	—	—	21.7	T.B. —
60 " ...	+	+	—	41.7	T.B. +
90 " ...	+	+	—	60	T.B. —
120 " ...	—	+	—	51.7	T.B. +
150 " ...	—	+	—	41.7	T.B. +
180 " ...	—	+	+	54.1	T.B. +

The quantity of resting juice obtained was only sufficient for the inoculation test. It was therefore used as a control in order to be quite sure that the gastric secretion from the case under observation contained no tubercle bacilli. The animal thus injected remained free from tuberculosis.

CASE II.

Healthy adult female clinically free from tuberculosis. In this case three samples of gastric juice were mixed with an emulsion of tubercle bacilli of a known virulent strain. This emulsion, originally containing 2,000 million organisms per cubic centimetre, was diluted down until *theoretically* it only contained 1,000 bacilli per cubic centimetre; 6 c.cm. of gastric

juice were mixed with 0.1 c.cm. of this diluted emulsion, so that only 100 bacilli (exposed to the action of gastric juice) were contained in each inoculation of the mixture.

Of course, this can only be regarded as empirical, but we wished to show, if possible, whether the gastric juice could cope with small doses of bacilli. The test was made at 37° C. for an hour and a half as before. The results obtained were as follows:

Sample of Gastric Juice.	Starch.	Mucus.	Bile.	Total Acidity in Terms of N/10 NaOH.	Guinea-pig Inoculation.
Resting ...	—	+	+	40	T.B. —
15 minutes ...	+	+	—	20	
30 " ...	+	+	—	16	T.B. —*
60 " ...	+	+	—	40	
90 " ...	+	+	+	32	T.B. —
120 " ...	—	+	+	28	
150 " ...	—	+	+	14	

* Typical caseous abscess at site of inoculation was noted on the twelfth day after inoculation, but no tubercle bacilli could be found either in direct films or by anti-formin method. A control inoculation of the extremely dilute emulsion used in this experiment was also made in a guinea-pig, and proved negative. It seems probable, therefore, that the few tubercle bacilli present in the emulsion were lost during manipulation (for example, on the sides of the pipette).

CASE III.

Adult female convalescent from salpingectomy. No signs of tuberculosis. In order to make the experiments approximate more nearly to natural conditions the samples of gastric juice in this case were mixed with a mouth-wash obtained from a case of pulmonary tuberculosis with bacilli in the sputum. In the case of each sample 2.5 c.cm. gastric secretion was added to 2.5 c.cm. mouth-wash. The time of exposure at 37° C. was the same as in the last experiment (that is, ninety minutes).

Sample of Gastric Juice.	Starch.	Mucus.	Bile.	Total Acidity in Terms of N/10 NaOH.	Guinea pig Inoculation.
Resting ...	—	+	+	8	T.B. +
15 minutes ...	+	+	+	10	
30 " ...	+	+	—	10	
60 " ...	+	+	—	24	T.B. +
90 " ...	+	+	—	22	*
1:0 " ...	—	+	+	8	T.B. —

* A control inoculation of this sample without the addition of mouth-wash gave rise to no tuberculosis in a guinea-pig.

CASE IV.

Adult male with fracture of right tibia and fibula. No signs of tuberculosis. The routine followed in the last experiment was adopted again, except that (a) a different case of pulmonary tuberculosis from which to obtain the mouth-wash was used, the first having died in the interval, (b) the time of exposure of gastric secretion to mouth-wash was lengthened from one and a half to three hours. The results obtained were:

Sample of Gastric Juice.	Starch.	Mucus.	Bile.	Total Acidity in Terms of N/10 NaOH.	Guinea-pig Inoculation.
Resting ...	—	+	—	20	T.B. +
15 minutes ...	+	+	—	6	
30 " ...	+	+	—	48	
60 " ...	+	+	—	38	T.B. +
90 " ...	+	+	—	40	*
120 " ...	+	+	—	62	T.B. +
150 " ...	—	+	—	52	

* This sample was inoculated into a guinea-pig as a control of the gastric secretion. No tuberculosis resulted.

CONCLUSIONS.

1. Gastric juice removed from the stomachs of persons free from gastro-intestinal disease, at various intervals of time after an oatmeal test meal, showed very little power of destroying (a) tubercle bacilli in sputum which had been exposed to it for ninety minutes, and (b) tubercle bacilli in mouth-washes which had been exposed to it for ninety and one hundred and eighty minutes respectively. In one case a total acidity of 62 (Case IV), in another of

54.1 (Case 1), and in a third of 24 (Case III) failed to destroy the bacillus.

2. The gastric secretion may possibly have destroyed the tubercle bacilli in a very weak emulsion to which it was exposed under similar conditions, but the number of bacilli used (100) was so small that it cannot be considered a fair test, and even the control test with this weak emulsion proved negative in a guinea-pig.

3. The protection against the tubercle bacillus afforded by the gastric secretion is apparently by no means perfect. But it must be remembered that the dilution of contents and the motor activity of the stomach probably play a large part in this mechanism of protection, and these latter factors cannot be satisfactorily experimented upon *in vitro*.

These results are in general agreement with the conclusions arrived at by Allan Macfadyen⁶ under different conditions and with bacteria other than *B. tuberculosis* as long ago as 1887.

4. In the four cases examined the untreated gastric juice contained no tubercle bacilli as judged by the inoculation test. We know of no records which show whether or no tubercle bacilli have been found in gastric juice in persons not suffering from clinical tuberculosis. This point may have important bearing on the portals of entry of the bacillus.

REFERENCE.

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AN OPERATION FOR INGUINAL HERNIA.*

BY

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SEVERAL cases in quick succession presenting difficulties in the efficient excision of the sac led me to devise a new method by which these and other troubles could be easily and successfully dealt with when they arise.

I approach and reach the back of the inguinal canal from a middle line incision in the lowest part of the abdominal wall. Unless compelled by some complication I do not open the general peritoneal cavity.

All the work is done in a space made in the subperitoneal tissue. I have operated in this way upon forty-one patients. In the first nine I made all the incisions longitudinal. In the remainder I have traversed the abdominal walls by Pfannenstiel's method. I will describe an uncomplicated operation.

The patient is placed in the Trendelenburg position, and the operator stands on the side opposite the hernia. A transverse skin incision 4 or 5 inches long is made $1\frac{1}{2}$ inches above the symphysis pubis. Its centre corresponds with the middle line.

A transverse incision is made in the aponeurosis of the rectus abdominis of both sides, care being taken not to injure either linea semilunaris. The linea alba is undercut upwards and downwards, to within one or two inches of the umbilicus, and to the symphysis respectively: in doing so the sheath of each pyramidalis muscle will be opened. The opening thus made in the aponeurosis is retracted up and down and the subperitoneal tissue exposed by separating the abdominal muscles in the middle line. The peritoneum and its contents are pushed up on both sides, and if necessary kept up by packing.

Two retractors are inserted; they should have long, separate, and blunt prongs. The lower retractor, by far the most important instrument in the operation, should pull the abdominal wall downwards, outwards, and forwards on the side of the operation. Forwards to lift up the abdominal wall. Its prongs should reach the deep epigastric artery and vein. I should not advise anyone to proceed with the operation until he is satisfied that this retractor is in its proper position. The upper retractor pulls the structures outwards. After more completely pushing upwards the outer part of the peritoneum and thoroughly

exposing the iliac fascia, the neck of the sac can be seen entering the inguinal canal. The deep epigastric artery and vein are delimited and separated from the inner part of the neck of the sac. Cheyne's dissector is a very useful instrument to use for this purpose. The spermatic veins and vas deferens, with its vessels, are found and separated from the whole length of the exposed sac. These structures are usually on the outer and under surface of the sac.

Having cleared the sac, it is pulled out of the canal by gentle continuous traction in the direction in which it lies. If there are no indications of the possibility of its easy extraction, the sac is cut and the canal portion replaced. The remains of the sac in the subperitoneal space are then radically excised. (Congenital herniae would belong to this type.) The neck of the sac, including part of the parietal peritoneum, is then transfixed and removed. Finally, the inguinal canal of the opposite side is examined, and if abnormalities exist they are treated on the same lines. I have only once had to ligature a vessel in the subperitoneal space, and that was a small branch of the deep epigastric vein.

I will now describe (1) the complications and structures with which I have met, (2) the herniae I would avoid, and (3) the herniae I would select for this operation.

1. Complications and Structures Encountered.

I have found and removed unsuspected and potential hernial sacs from the opposite side in three patients. In others I have cleared from the internal opening of the canal of the opposite side firmly attached dimples of the parietal peritoneum. In others I have removed fibrous cords that passed from the parietal peritoneum into the canals.

In one patient the urinary bladder occupied the canal and practically was a part of the neck of the sac. The peritoneum was peeled from the bladder, and the sac was radically excised. When I meet this complication again I should distend the bladder with fluid; this would render the separation of the peritoneum safer and easier. I may say here that it was a sequence of herniae in which the bladder appeared that made me devise some procedure by which I could deal more adequately with this complication. I am sure the operation I have described to you allows a complete and safe method.

In seven cases I found the urachus, which bore the same relation to the sac as that occupied by the bladder. This was traced to its union with the bladder, and it contained a good deal of unstriated muscle, very tortuous patent and small arteries and some fat.

In a few patients I have traced adhesions between bowel and sac, and omentum and sac into the general peritoneal cavity, which I have been compelled to open to satisfactorily clear them away. The herniae in these instances appeared to be reducible before operation.

The obliterated hypogastric artery was recognized in the sac in three cases. In one of these the lumen of the vessel was not obliterated at the point of section.

From one patient I removed a small sac entering the canal, and missed a much larger one that was plastered against the iliac fascia and outer part of the inguinal opening. It was this mistake that makes it so essential to expose the iliac fascia.

In another patient I had the following unfortunate experience. I had removed the sac on the left side and found an unsuspected sac entering the internal opening on the right side. I congratulated myself on removing these two sacs from the same opening. In six weeks the patient returned with a direct hernia on the right side. Rightly or wrongly I associated my operation with this new hernia and determined to take Mr. Victor Bonney's advice and adopt Pfannenstiel's method of traversing the abdominal wall.

As an unusual complication I may mention that through the same opening I have removed an appendix from a patient who suffered from appendicitis and inguinal hernia.

2. Herniae to be Avoided.

The herniae I would not select for this operation are direct hernia, irreducible enterocoeles, hernia in male children under 7 or 8 years, and old herniae in which the internal opening has been dragged down opposite the external.

3. Herniae to be Selected.

I would select herniae in females of any age, and all uncomplicated inguinal herniae in males over 7 or 8. I would not exclude irreducible epiploceles.

* Read before the Section of Surgery, Royal Society of Medicine, December 7th.