post-temporal bone of the whiting (Fig. 2). It is one of a string of bones attaching the pectoral girdle to the back of the skull. From the shape of the bone one can see that the pain was caused by the bone presenting at the pyloric orifice with the two prongs in front, so that it was impossible for it to pass in this way. Taking something into the stomach evidently had the effect of dislodging it for the time being. The bone presented a

FIG. 2.—Showing the position of the post-temporal bone of the whiting.

dark appearance, no sign of digestion being apparent. I suffer from pernicious anaemia and have achlorhydria, which may account for the bone not having been digested.

The case is interesting because of the length of time the bone was retained in the stomach. It seems a wonder the bone did not perforate the stomach wall, and it was only a fortunate chance which allowed the bone to pass the pylorus.

It may be that many of the cases of atypical duodenal ulcer one sees are due to bones and other objects being in the stomach. A few years ago I removed from a man's rectum a piece of twig three inches long and three-sixteenths thick, which had been embedded there for four years. In this case the man had suffered from indigestion for a long time before the pain was transferred to the rectum.

Commenting on this case the other author (G. A.) referred to the case of triple perforation of the ileum by fish bones (brill) reported in the *British Medical Journal* (1928, i, 307), and suggested that it was advisable to be always on the look out for foreign bodies perforating the bowel wall as a possible cause of an unexplained peritonitis, labelled idiopathic or haematogenous, somewhat unsatisfactorily in many cases.

Three days later the following case was referred to hospital by Dr. Sinton of Headingley.

W. L., aged 62, a clothworker, was admitted to hospital on January 12th complaining of severe generalized abdominal pain. This pain commenced very suddenly, and without warning, twenty hours previously, across the lower abdomen, giving rise to a strong desire to defaecate. It was of a colicky type, with only occasional brief intervals of relief, bringing him almost double to the floor, and making rest quite impossible. Nausea was present from the beginning, but vomiting did not occur until nine hours later. All symptoms increased in severity, compelling him to call in Dr. Sinton, who dispatched him to hospital immediately. On admission the patient looked ill and was cyanosed. Pulse rate was 120, temperature 97° F., blood pressure 140/80, respirations 20. The tongue was dry, dirty, and coated. Examination revealed a hard, rigid abdomen, which could not be overcome, and which was extremely tender. There was slight pain on flexion of the right leg. Rectal examination revealed high anterior tenderness, but was otherwise negative. A diagnosis of general peritonitis was made with no little assurance, but the cause remained obscure. The patient volunteered no information when he was asked if he had

swallowed a foreign body. Operation was carried out immediately under spinal novocain anaesthesia (150 mg. in 15 c.cm. cerebro-spinal fluid; level 1-2 dorsal) after preliminary medication consisting of hypodermic injections of morphine 1/4 grain, atropine 1/100 grain, and adrenaline (1 in 1,000) 15 minims. Free sero-purulent effusion was present in the general peritoneal cavity, especially in the lower part. A normal appendix was removed. Having in mind, in view of the recent discussion, the possibility of a foreign body, a perforated diverticulum, or a stercoral ulcer of the large bowel proximal to a growth, the surgeon on searching the pelvis felt a sharp foreign body projecting from the anterior aspect of the lower sigmoid colon. This proved to be the sharp end of a rabbit's rib, which when removed measured 2 inches (Fig. 3). This bone was shown to the patient at the time of removal, and he at once remembered having partaken somewhat vigorously of a hearty dish composed of rabbit, onions, and potatoes two and a half days prior to the onset of the pain. The perforation was sutured, infolded, and an omental graft placed over it. The peritoneal cavity was drained. Convalescence proceeded uneventfully, and the patient was discharged from hospital cured four weeks later.

FIG. 3.—Showing the rib bone of a rabbit, which had perforated the lower sigmoid colon, giving rise to general peritonitis. (Natural size.)

The case is placed on record because it is felt that, occasionally, foreign bodies perforating the bowel and producing general peritonitis are missed. It is advisable in these obscure cases to inquire very carefully into the nature of meals partaken prior to the onset of the malady.

We are indebted to Mr. Collinson, under whose care the patient was admitted, for permission to report the case, and to Miss E. M. Wright for Figure 2.

THE GONOCOCCAL COMPLEMENT-FIXATION TEST

BY

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The object of this paper is to demonstrate the need for the complement-deviation test as a means of efficient diagnosis and treatment of gonorrhoea. Although much work has been done in Europe by R. Förster,¹ A. Cohn,² and P. Timoféeff,³ in America by Kolmer⁴ and Kilduffe,⁵ and in this country by Thomson,⁶ Osmond,⁷ and Osmond and Oliver,⁸ it is regrettable that the merit of the test is not more appreciated, and that it is, in consequence, insufficiently used. The opinions expressed below are based on the study of the clinical histories and serum reactions of approximately 7,000 cases.

RATIONALE OF THE TEST

The test, the technique of which I have described elsewhere,⁹ is highly specific (0.03 per cent. false positives in 1,133 cases¹⁰), but it must be clearly understood that it demonstrates the presence or absence of specific gonococcal antibody in the blood, and not the presence of gonococci in the tissues. Thus all results must be read in conjunction with the clinical history, and judged accordingly. The production of the specific antibody depends on: (a) the age of the infection; (b) the anatomical spread of the disease; (c) the reaction of the

tissues to the presence of gonococci; and (d) the stage of the infection at which treatment is instituted and the efficacy of therapeutic action.

AGE OF INFECTION

In order to estimate the stage of infection at which a positive reaction may be expected the following graph was constructed from the results of the tests performed for the first time on serums from untreated cases in which the age of the infection was accurately known.

Graph showing the percentage of positive results given by the gonococcal complement-fixation test during the first six weeks after exposure to infection.

From the above it will be seen that the likelihood of obtaining a positive result varies, within limits, directly with the age of the infection. Thus, in the first week after exposure to infection only 8 per cent. (14 out of a total of 177 cases) of positive reactions were obtained. There is a rise to 21 per cent. (48 positives from 184 cases) in the second week, 68 per cent. (62 positives from 91 cases) in the third week, 89 per cent. (42 positives from 47 cases) in the fourth week, and 100 per cent. (46 positives from 46 cases) in the fifth and sixth weeks. From these figures it is apparent that the diagnostic value of the test is greatest from the third week onwards. On the other hand, positive cultures and smears are usually obtained during the first three weeks of infection. The "subacute" infections often present problems for accurate diagnosis, particularly in cases in which the patient has attempted to cure himself, but has only succeeded in driving the gonococci into the deeper tissues and at the same time has grafted a secondary infection on the original gonorrhoea.

ANATOMICAL SPREAD OF DISEASE

This depends on the age of the infection, the reaction of the tissues, and the treatment, if any, adopted. Case records show that when, in the male, the posterior urethra, prostate, vesicles, or the epididymes, and, in the female, the cervix, cervical canal, uterus, or Fallopian tubes become involved, a positive reaction is the rule.

REACTION OF THE TISSUES

It appears that the tissues respond somewhat slowly to the presence of gonococci, although antibody production commences during the first week of infection. Three cases which were exceptions to this rule were met with during the course of this investigation, and one may be cited.

The patient was an unemployed domestic servant, aged 22, who, when first seen, complained of a vaginal discharge of three days' duration, and admitted a definite exposure to infection. Gonococci were identified in smears and cultures, and the complement-fixation reaction was negative. After four months' routine treatment, gonococci were obtainable from the cervical secretion, but the complement-fixation reaction

was negative. A course of gonococcal detoxicated vaccine was given over a period of two months, and at the end of this time gonococci were still present in both the urethra and the cervical canal, whilst the complement-fixation reaction remained negative. Routine treatment was continued until eight months after the original infection, when the patient was clinically cured, whilst bacteriological and serological investigation proved to be negative. Thus, throughout the disease, no antibody production was demonstrable, in spite of a definite infection of the cervical canal by the gonococcus and of the administration of large doses of gonococcal vaccine.

EFFECT OF TREATMENT

If adequate treatment is adopted early—that is, during the first week of infection—the reaction may become only weakly positive, or it may even remain negative throughout the course of the disease. These cases are usually rapidly cured, and the lack of antibody production (hence a negative serum reaction) is possibly due to the anatomical localization of the infection affording less opportunity for interaction between the gonococci and the tissues.

Once the reaction has become positive it does not weaken until the infection has been eradicated from the body. After the acute stage of the infection has passed it is usually difficult to demonstrate foci of infection by means of smears or cultures, especially in the female. Moreover, the presence of pus alone is not necessarily due to the gonococcus, and unless a complement-fixation test is performed there is no certain means of ascertaining whether the inflammation is due to the gonococcus, to a secondary infection, such as staphylococci or coliform bacilli, or to a chemical irritation. As soon as the gonococcal infection is cured, the test, although positive, tends to weaken, and in about three to four months a clean negative result is usually obtained. To demonstrate this, 50 cases of uncomplicated gonorrhoea were followed through from the onset of the disease to the point at which the reaction became negative, monthly serum tests being performed in each case.

TABLE I.—Showing Relationship between Clinical Condition and Serum Reactions of 50 Cases of Uncomplicated Gonorrhoea

Months after Infection	Clinically Cured	Serum Reactions		
		Negative	Doubtful	Positive
1st month	0	0	0	50
2nd month	13	7	5	38
3rd month	29	20	2	28
6th month	50	50	0	0

The results tabulated above show that none of the 50 cases investigated were clinically or serologically cured one month after infection. At the end of the following month, of the 13 cases that were clinically cured 7 gave negative, 5 gave doubtful, and 1 gave a positive reaction. Three months after infection 29 cases were clinically cured, and of these 20 gave negative reactions, 2 were doubtful, and 7 still resulted in positive reactions. Finally, six months after infection, 50 cases were clinically and serologically cured.

When gonococcal complications such as salpingitis or arthritis occur, more strongly positive reactions than usual are obtained, and in these cases quantitative tests are performed by using increasing dilutions of serum up to 1 in 100 (the standard dilution in test being 1 in 5). When a cure is established there is a persistent weakening of the positive result until a clean negative result is recorded—for example, ++ (1 in 60), ++ (1 in 30), ++ (1 in 10), +, ±, ± to negative. If there is no reduction in the strength of the reaction in spite of apparent

clinical cure, it is definite evidence that an active focus of infection persists. In cases where vaccines have been used in an attempt to stimulate the tissues to combat the disease during the course of treatment a positive reaction (for example, +) may be converted into a strongly positive reaction (for example, ++, serum diluted 1 in 40), but this increase usually drops to the original strength (+) within six weeks after suspension of the vaccine treatment. In about 50 per cent. of cases treated by gonococcal vaccine no increase in the amount of antibody is recorded by the test.

The test is applicable to children as well as to adults. With the co-operation of Dr. Dorothy Brown, medical officer at Coldharbour House, Croydon, some 47 cases of vulvo-vaginitis in children were investigated. Gonococci had been demonstrated during the course of the disease in 42 of these cases. When the complement-fixation test was performed, 29 gave positive results, 7 were weakly positive (6 were old-standing treated cases and 1 an early case of a week's duration), and 6 which gave negative results were clinically cured at the time of the test. The remaining 5 cases in which no gonococci had ever been found gave negative reactions. Therefore it would appear that results similar to those found in the adult are to be obtained in children.

EXCEPTIONS

During the course of this investigation three types of exception to the general rule were met:

Failure to Produce Antibody.—Three cases of gonococcal infection, with no production of antibody, repeatedly gave a negative complement-fixation reaction.

Intercurrent Infection.—In one undoubted case of gonorrhoea (gonococci isolated in smears and cultures, complement-deviation reaction ++) of two months' duration, the patient during treatment developed a sore throat (Wassermann reaction negative). This was followed a few days later by an arthritis of the left elbow, which clinically was not typical of a gonococcal arthritis. A short-chained streptococcus was cultured from both the throat and the elbow.

"Cross Fixation."—In two cases the possibility of false positive reactions being given by the antibodies of *Micrococcus catarrhalis* could not be excluded. The occurrence of this so-called "cross fixation" has been pointed out by Oliver¹¹ and might result in a false positive reaction being given by the serum of a patient cured of gonorrhoea, but suffering from a catarrhal condition of the nasopharynx. An attempt was made to deal with these cases by means of monthly parallel quantitative tests on the serum of the patient demonstrating a steady progressive fall in the strength of the positive reaction when using a gonococcal antigen, while the strength of the reaction when using an antigen of *Micrococcus catarrhalis* remains constant. This is shown in the following table, in which the strength of the highest dilution of serum which gave a positive reaction is tabulated.

TABLE II

Monthly Reactions	Highest Dilution Serum giving a Positive Reaction	
	Gonococcal Antigen	Catarrhalis Antigen
1st reaction	1 in 60	1 in 8)
2nd reaction	1 in 30	1 in 80
3rd reaction	1 in 10	1 in 80
4th reaction	1 in 5*	1 in 80
5th reaction	Partial positive at 1 in 5	1 in 8)

* Standard dilution of serum used in the test.

While this is not regarded as proof of an infection by *Micrococcus catarrhalis* as opposed to one by the gonococcus, it is at least suggestive, although experience of such cases is very limited.

INTERPRETATION OF RESULTS

The interpretation of results must be correlated with the clinical history if a reliable opinion is to be given on the result of a test. The usual notation is used:

++ or +± = strongly positive
+ = positive
± = weakly positive
- = negative

A strongly positive or positive result is definite evidence of a gonococcal infection, and it may be taken that the posterior urethra, etc. (or in the female the cervical canal), have become involved. A weakly positive result (±) is obtained in (a) early cases (one to three weeks after infection), (b) old-standing cases which clinically are cured, but in which enough "residual antibody" is still present in the serum to cause this result. A negative result obtained when gonococci are exhibited in the secretions should be regarded as (a) an early infection of under twenty-one days' duration, (b) if over twenty-one days' duration, an unusual case in which the defensive mechanism of the body has not responded to the infection and in consequence no antibody has been formed. A negative result obtained when no gonococci are demonstrable indicates that the case is (a) cured, all "residual antibody" having been eliminated from the blood, or (b) not a gonorrhoeal infection.

CONCLUSIONS

1. The complement-fixation test for gonorrhoea as performed by this method is as useful in the diagnosis and treatment of gonorrhoea as the Wassermann reaction is in syphilis.

2. No patient should be discharged as cured of gonorrhoea unless the blood serum gives this negative complement-fixation reaction.

3. A negative result, if read in conjunction with the history and other pathological findings (for example, smears and cultures), has a definite significance.

4. A positive reaction is definite evidence of a present infection by the gonococcus or of an infection in the immediate past.

5. If the test were performed on the serum of patients suffering from arthritic joints, tenosynovitis, iritis, and particularly in women suffering from abdominal pain of obscure origin, fewer errors in diagnosis might be made.

6. The test should be instituted as a routine procedure in all venereal disease clinics.

I wish to thank Colonel L. W. Harrison for permission to publish that portion of the work done at St. Thomas's Hospital V.D. Clinic while I was acting as assistant pathologist to the department; Dr. Anwyl Davies, director of the Whitechapel Clinic; and the medical officers of both clinics for their co-operation and help.

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