ON IODINE-SPIRIT CATGUT.*

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No link in the aseptic chain requires to be more thoroughly tested than the sterility of the ligature and suture material buried in the tissues. Thousands of yards of catgut are used every year by the busy surgeon, and every inch of it is a possible source of infection. Bottle catgut as supplied by the manufacturer is expensive, and faith in it speedily wanes, so that the operator sooner or later finds it necessary to experiment in order to determine the best method by which he may prepare reliable catgut for his own use. I made a series of experiments, some of them involving complicated methods of preparation and the use of special apparatus, but many were attended by undue difficulty and by failure to secure uniformity in the finished material, and I was thus led to discard in turn Elsberg's ammonium-sulphate catgut, as used in the Eppendorf Clinic at Hamburg; cumol catgut, at one time the stand-by in Leipzig; formalin catgut, and others. It was only some two years ago that I discovered a method so simple and reliable as to mark it out as the plan of choice.

The cardinal attributes of an ideal catgut were tabulated by Moschcowitz as follows:¹

1. It should be absolutely sterile.
2. In the course of its preparation it should not lose any of its tensile strength.
3. It should be readily and simply prepared and without any undue expense.
4. It should be absorbed completely, but only after it has served the purposes for which it was intended.

It is my desire to show in this paper that iodine-spirit catgut fulfils all these conditions of an ideal catgut, and that it can be easily prepared and stocked by the surgeon or general practitioner without special apparatus, at little expense, and with uniformly good results. A clinical experience of over 1,000 operations in which this catgut has been employed in my practice, including all forms of abdominal work, general and gynaecological, has convinced me that it is trustworthy in all circumstances. Laboratory experiments incorporated in the bacteriological report given below support and form a scientific basis for these clinical observations.

A short summary of the history of the sterilization of catgut by iodine is a necessary foreword to the thorough understanding of the method to be described.

The advantages of iodized catgut were first brought before the surgical world by Claudius in a paper published in 1902, on a method for "Sterilization and Sterile Preservation of Catgut,"² followed in 1903 by a statement in the same journal of the results obtained.³ By his method, which we may call the "iodine-water method," raw catgut is kept for eight days in a solution of iodine 1 part, potassium iodide 1 part, and water 100 parts. When it is to be used it is placed in 3 per cent. carbolic solution or sterile saline, by which the excess of iodine is washed away. From lying in the iodine the catgut assumes a deep black colour and is absolutely sterile. In this 1 per cent. aqueous solution of iodine staphylococci are killed in three minutes and anthrax spores in twenty hours. Claudius made many experiments, and found that after eight days in the solution no growth of aerobes or anaerobes from infected paper was observed. He advised that the catgut, before using, should be placed in carbolic or sterile fluid for a short time—not to exceed one to one and a half hours—as it was found that after twenty-four hours in such solution all the iodine and the peculiar consistence was gone. In 25 patients operated on there was no inflammatory reaction and the gut was completely absorbed in from twelve to sixteen days.

Von Hippel⁴ reported that raw catgut treated in this way was usually free from germs in thirty minutes and from anthrax spores in one and a half hours, but the latter observation is certainly open to doubt.

Zimmer found that this catgut behaved as follows in 250 cases:

98.75 per cent. of all wounds healed <i>per primam</i> .
1.25 " " " <i>per secundam</i> .

* Communicated to the Aberdeen Medico-Chirurgical Society.

Bloch of Copenhagen found it excellent and used it extensively, but reported that after seven months' keeping it was somewhat brittle, and Professor Wanschier (Copenhagen) made a similar complaint.

In an excellent article,⁵ Alexis V. Moschcowitz of New York described a modification of the Claudius method, which he had found it necessary to institute, owing to the brittleness of the catgut, which he discovered to be due to the long immersion in the aqueous iodine solution. After the statutory eight days he removes the catgut from the solution into sterile Petri dishes, in which it is kept till it is to be used. From his clinical experience and from over 170 experiments, which are detailed in his paper, he concludes that:

1. The dry iodine catgut is absolutely sterile.
2. It is impossible to infect it by ordinary means.
3. Its imbibition with iodine is not sufficient to act as an irritant on the tissues.
4. Its tensile strength is superior to raw catgut and to that prepared by the sublimate and alcohol method.
5. It is easily and cheaply prepared.
6. It is absorbed only after it has served the purposes for which it was intended.

Recognizing the great advantages of iodized catgut, and though aware that antiseptics act more strongly in an aqueous solution, I decided some two years ago to give a fair trial to a method described by Salkindsohn, in which spirit is used instead of water as the iodine medium. His directions are to use tincture of iodine 1 part, proof spirit 15 parts, and to keep the catgut immersed for eight days before using.

I have used catgut so prepared in many hundreds of operations as ligature and suture material, and have nothing but good to say of it. After some months' clinical experience the advantages of the method impressed me so much that I thought it wise to have a series of observations conducted by a bacteriologist with a view to establishing the procedure on a sound scientific basis. I was fortunate in securing the kind help of my friend, Dr. G. G. Macdonald, Travelling Thompson Fellow of Aberdeen University, who conducted his investigations in the bacteriological laboratory of the London Hospital. His report, which I subjoin, entirely corroborates all that I have found clinically, and proves conclusively that the method is reliable in every way, and is specially fitted for general use from its simplicity.

Dr. Macdonald's report is as follows:—

The iodine solution used in the experiments was prepared according to the following formula:

Tincture of iodine (B.P.) 1 part, proof spirit 15 parts. Since proof spirit contains 49.24 parts of alcohol to 50.76 parts of water by weight this is very approximately the same solution as was recommended by Salkindsohn, who uses 50 per cent. alcohol.⁶

The catgut was wound on glass spools and placed in the solution of iodine for periods varying from five minutes to ten days. The spools were then washed each in a fresh quantity of sterile normal saline (0.85 per cent.) solution for one hour. Thence each was transferred to tubes containing 10 c.cm. bouillon which were then incubated at 37° C. for four days. This includes the first series of experiments.

The spools thus found to be sterile were impregnated with *Staphylococcus pyogenes aureus*, *Bacillus typhosus*, and spores of *Bacillus mesentericus* and anthrax. This was done by immersing the spools in twenty-four-hour broth cultures of the staphylococcus and of the *Bacillus typhosus* and incubating them for twenty-four hours at 37° C. The infection with *Bacillus mesentericus* spores was done by immersion in a three-day-old broth culture for twenty-four hours and that with anthrax spores by the usual method for the preparation of anthrax-spore silk threads. In one set of experiments with *B. mesentericus* spores the catgut was tied in skeins. They were washed in sterile normal saline solution, transferred to broth and placed in an incubator at 37° C. for four days as in the first series.

The results are exhibited in the following table, from which it is obvious that catgut infected with staphylococcus or the typhoid bacillus is sterile in two to three hours, with anthrax spores in two to three days, and with the highly resistant spores of *Bacillus mesentericus* in four to six days.

Each group of experiments was performed with freshly prepared solutions of iodine, as it would appear that the iodine is used up in the process. Thus in the residual iodine solution from the first batch of experiments were immersed spools infected with *Bacillus typhosus* and *Staphylococcus aureus*. These were not sterile till six to twenty-four hours, compared with three hours in the fresh solutions. Hence the importance of having a large excess of the solution bathing the catgut spools.

Sterilization of Catgut by Iodine-Spirit Method.

Time in iodine-spirit.	Commercial catgut, wound on spools and placed in iodine-spirit for varying periods as follows: (In the catgut staphylococcus, <i>B. prodigiosus</i> and some sporing organisms were found by cultivation.)	Sterilized catgut infected with <i>Staphylococcus pyogenes aureus</i> , as above.	Sterilized catgut infected with <i>B. typhosus</i> , as above.	Sterilized catgut impregnated with anthrax spores. (Killed by 4 to 7 minutes' boiling.)	Sterilized catgut infected with spores of <i>B. mesentericus</i> (resisted 18 mins. at 100° C.)	Sterilized catgut (tied in skeins) infected with spores of <i>B. mesentericus</i> more resistant than the above (being killed by 23 and not by 20 minutes' boiling.)
15 mins.	S.A., B.P., sp.	...	T.	...	...	...
30 mins.	S.A., B.P., sp.	S.A.	T.	...	...	...
1 hr.	S.A., sp.	S.A.	T.	B.A.	...	...
2 hrs.	S.A., sp.	S.A.	T.	...	M.	M.
3 hrs.	sp.	-	-	...	...	...
5 hrs.	sp.	-	-	...	M.	M.
6 hrs.	sp.	-	-	B.A.	...	...
1 day	sp.	-	-	B.A.	M.	M.
2 days	sp.	-	-	B.A.	M.	M.
3 days	sp.	-	-	-	M.	M.
4 days	-	-	-	-	M.	M.
5 days	-	-	-	-	-	N.
6 days	-	-	-	-	-	-
7 days	-	-	-	-	-	-
8 days	-	-	-	-	-	-
9 days	-	-	-	-	-	-
10 days	-	-	-	-	-	-

A minus sign - signifies sterile.
 S.A. signifies *Staphylococcus pyogenes aureus*.
 B.P. " *Bacillus prodigiosus*.
 sp. " sporing organism.
 T. " *Bacillus typhosus*.
 M. " *Bacillus mesentericus*.
 B.A. " *Bacillus anthracis*.

That the catgut thus sterilized possesses considerable antiseptic properties was demonstrated by inoculating a bouillon tube with *Staphylococcus aureus*, and then immersing in it a spool of catgut which had been in the iodine solution for seven days. Growth failed in each case; in the controls, where the iodine was removed by washing in 100 c.cm. sterile salt solution, abundant growth was present after twenty-four hours. This antiseptic property would tend to prevent infection from the hands during the manipulation of the catgut at operations.

From two years' constant use of the iodine-spirit catgut I venture to summarize as follows:

1. It is sterile. Dr. Macdonald's experiments and the results of its extensive use at my operations show this conclusively. It has, moreover, as pointed out above, the same antiseptic properties as Moschcowitz claims for dry-iodine catgut.

2. It loses none of its tensile strength in preparation, and, what is more important and an advantage over Claudius's catgut, it can be stored indefinitely in the solution in which it is prepared without becoming brittle. The catgut is soft and very nice to handle.

3. It is readily and simply prepared, and without any undue expense. This is an important desideratum, and I know of no method which can in any way compare with it in this respect. Any one can prepare the catgut with the greatest ease and with absolute certainty of result. I may say that for hospital work my house-surgeon prepares all the catgut required, and for private work the theatre nurse at a nursing home is quite competent to carry out the process. The transference to sterile Petri dishes in Moschcowitz's dry-iodine method involves a risk of contamination which is not possible here. All that is required is a glass jar, a supply of iodine-spirit solution, commercial catgut (preferably Hartmann's), and a few glass spools. I would give the following hints

as to the preparation of the catgut: Ordinary glass tubing about the thickness of the little finger should be cut in lengths of 2 in. This is long enough to take one length of Hartmann's catgut in single layer without knotting. The catgut must be tightly wound on the tube, or, what is better, the tube should be rolled into the catgut as described in Binnie's *Operative Surgery*. The catgut is first fixed, either by tying it through or round the tube, and when wound on is fixed with a slip loop below the last turn. The spools are immersed in the solution and are kept there indefinitely till they are to be used. They must not be used till the eighth day after immersion, and for guidance the date of immersion and the size of the catgut should be noted on a small label on the side of the glass jar. No. 2 catgut I find most useful for ordinary purposes, and a larger supply of it should be prepared than of the other sizes. If many spools are immersed in one jar and are not used for some weeks after immersion, it is well to add fresh iodine-spirit solution at intervals of two to three weeks, so that one may be certain that there is always an excess of iodine bathing the catgut.

4. It is absorbed completely, but only after it has served its purpose. I have had no trouble from delayed absorption of ligature or suture. A fair test of this is its suitability for subcuticular suture.

REFERENCES.

¹ New York Medical Journal, May, 1904. ² Deutsche Zeitschrift für Chirurgie, 1902, Bd. 64, Hefte 5 and 6. ³ Ibid., Bd. 69, Hefte 5 and 6; see also *Bulletins et Mémoires de la Société de Chirurgie de Paris*, 1902, Nos. 4 and 5. ⁴ Wiener med. Presse, 1903. ⁵ Annals of Surgery, September, 1905. ⁶ Centralblatt für Chirurgie, Bd. 31, No. 3, 1904.

MEMORANDA:
MEDICAL, SURGICAL, OBSTETRICAL.

SPRAINS AND THEIR CONSEQUENCES.

As a continuation of this subject, the following account of an unusual lesion may be of interest:

The patient, D., slipped on his doorsteps and fell. He has no idea how he landed, but found that his right wrist was painful and that there was a slight abrasion on the radial side of the joint.

When I saw him first, a fortnight later, he had been applying lotion and had the arm in a bandage and sling. The wrist-joint was swollen, painful, and red; there was a small amount of fluid in it, and on movement there was distinct crepitus on the dorsal surface, which might or might not have been tendinous. A splint was applied, and two days later an x-ray photograph was taken, when it was seen that a large triangular piece of bone had been wholly or partly broken away from the dorsal edge of the lower or articular surface of the radius and projected above the dorsal surface of the bone. The splint was kept on for several days and both passive and active movements used every evening. The crepitus soon disappeared, and, movements being without pain, the splint was dispensed with at the end of a week.

Measured with calipers, the antero-posterior diameter of the right radius at its lower end is now about $\frac{1}{4}$ in. more than that of the left. Flexion is slightly limited, and there is slight tenderness over the seat of fracture.

As it is scarcely a month since the accident, the patient can look forward to practically normal use of his wrist.

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COINCIDENT EMBOLISM OF CEREBRAL, MESENTERIC, AND FEMORAL ARTERIES.

MRS. H., aged 67, was seized with severe pain in the abdomen about midnight on February 10th, and shortly afterwards began to pass blood per rectum. When seen by Dr. Jas. Macfarlane in the morning she had passed about half a pint of blood and the pain was still very severe.

Four hours later we were sent for again, as the family had noticed that the patient's speech had become indistinct, and we then found hemiplegia affecting the left arm and leg and the left side of the face. The discharge of blood had ceased, the abdominal pain was a little less, and the diminished rigidity rendered distinctly palpable a large tender swelling in the right iliac region. The question arose whether this might be an intussusception with