has to be continued beyond this period in patients in whom the large bowel is not involved, saline may be administered through the rectal route. Provided a narrow catheter is used, and provided the flow is intermittent—a half-hour in every hour—absorption by this method is satisfactory. From time to time, after suction has ceased, the patient again starts to vomit, and there must then be no hesitation in resuming this and the saline drip.

Any severe ileus is rare in cases so treated, but in the event of abdominal distension becoming increasingly great, intravenous pituitrin—1 c.cm. in 10 c.cm. of water or saline—is of the utmost value, and the passage of flatus and faeces is immediate.

As soon as stomach suction is stopped the diet may rapidly be built up, the inclinations of the patient being largely followed. An enema or colostomy wash-out is useful when the bowels fail to act normally. Sulphaguanidine is valuable in reducing the offensiveness of colostomy.

A course of penicillin is now given as a routine, either by periodic injections or by a continuous intramuscular drip, as not only is the drug of value in counteracting the sepsis of the actual wound, but it has been found that staphylococci and streptococci are normal contaminants of the peritoneum in such cases. Those associated with grossly dirty wounds have been given sulphadiazine in the intravenous drip. In such cases alkali has always been administered by the same route.

Factors in the Causation of Death.—First and foremost in the causation of death, as in all civilian types of abdominal catastrophe, is the period of time elapsing between the onset of the lesion and the start of the operation; the accompanying Table illustrates this point. It will be seen that among all cases coming to operation within 10 hours of the receipt of the injury the mortality is 20%, rising to 71% in those arriving after 20 hours.

Table showing Relation of Time of Wounding to Mortality Rate (54 Cases)

Time Factor	No. of Cases	No. of Deaths	Mortality (%)
Within 10 hours ..	30	6	20
20 " ..	17	10	49
Over 20 " ..	7	5	71

Coupled with this factor is the severity or otherwise of the lesion and associated extra-abdominal injuries. Of the six cases culminating fatally in the first group, five had gross and multiple injuries either inside the abdomen or associated with that lesion, and all died within 36 hours. The sixth patient died after operation for a post-operative obstruction.

Summary and Conclusions

The treatment of gunshot wounds of the abdomen is discussed. The use and advantages of pentothal anaesthesia in these cases are brought forward.

Pentothal has been found to be an ideal anaesthetic for abdominal surgery in shocked patients.

While this drug can be used with safety where there is only a mild degree of shock and where large doses have to be given, it is difficult of control and cannot be recommended in these cases.

The York Clinic at Guy's Hospital is the first psychiatric in-patient clinic to be established in this country as part of a general hospital in close association with the tradition of general medicine. It was not expected to be able to admit psychiatric patients till after the war, but the foresight of the York Council in proceeding with the building was justified, for at the end of 1943 the opening of the clinic for the purpose for which it was built was urgently requested by the Ministry of Health to provide beds for psychiatric casualties among officers of the Services. An immense amount of work had to be done by Dr. R. D. Gillespie (now Air Commodore, R.A.F.) and Mr. Lees Read to furnish and equip the clinic and prepare the organization. It opened on April 3, 1944, and a report on the first year's work has been issued as a cyclostyled document of six foolscap pages by the acting medical director, Dr. Felix W. Brown. There is undoubtedly a growing demand for treatment by modern psychiatric methods outside a mental hospital, and the York Clinic at Guy's has excellent opportunities to provide the right kind of training for future psychiatrists.

THE BACTERIOLOGICAL EXAMINATION OF INFECTED DENTAL PULP CANALS AND USE OF PENICILLIN IN PULP-CANAL THERAPY

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It has been shown by Bulleid (1938) and others that the commonest organism causing an infection of the pulp canal and periapical tissues is *Str. viridans*. Most strains of this organism are resistant to sulphonamides, especially in the presence of pus, but Fleming (1929) found that many are very sensitive to the action of penicillin, and therefore the effect of this chemotherapeutic agent on infected pulp canals seemed worthy of investigation.

Adams (1944) injected penicillin through the apical foramina in 2-c.cm. quantities, using 2,000 or 3,000 units for each injection. It is difficult to see how the periapical tissues could absorb this volume of fluid, and his criteria of sterility were not given; apparently an insufficient number of consecutive sterility results were accepted as adequate. He obtained a satisfactory result in all of 12 cases which he treated. It is surprising that in every case he apparently assumed that he was dealing with organisms sensitive to penicillin, although sensitivity tests were not carried out. In view of this work it was necessary to repeat the use of penicillin with more adequate bacteriological control.

It was clear that the common methods used in assessing the sterility of pulp canals—namely, (a) the absence of clinical signs of periodontitis, and (b) that the dressings removed appear clean and odourless—were inadequate for this work. Grossman (1936) showed that of 150 teeth, which by the appearance of the canal and odour of the dressing were judged by several dental practitioners to be ready for filling, 42% were still infected. A putrid odour may be produced by some organisms, especially anaerobic bacteria, but is often absent even in cases of gross infection by aerobic bacteria. A smear of the necrotic contents of the pulp canal, as suggested by Grossman (1940), is a very crude test of sterility. Radiographs of the periapical tissues may or may not reveal the presence of a rarefying osteitis due to infection, but this rarefaction must necessarily continue for some time even if the tissues have been rendered sterile; thus radiographic evidence is of little value. The only methods of ascertaining whether sterility has been achieved that are capable of withstanding criticism by bacteriologists are cultural methods, and the technique should be one which will demonstrate the relative number of organisms and the presence of anaerobic as well as aerobic organisms, and must entail no extra effort or skill on the part of the dental surgeon.

The ability to sterilize the pulp canal and periapical tissues has long been disputed. Gottlieb *et al.* (1938), Thoma (1943), and Grossman (1940) state that these tissues can be sterilized; and Sprawson (1926) concludes that "when tested by cultures and films they can usually, after prolonged treatment, be rendered sterile," but he found that six months or more was necessary to obtain sterility in some cases. Prinz (1911), Bulleid (1938), and others have stated that no antiseptic treatment will permanently sterilize a once-infected pulp canal. It is doubtful, however, if the bacteriological technique employed in all past work has been adequate to enable a final conclusion to be drawn.

Penicillin is a freely diffusible substance, and it was hoped that it would diffuse into the periapical tissues and increase their chance of permanent sterility.

Method

The following procedure was adopted for the bacteriological investigation of infected pulp canals and their treatment with penicillin. Single-rooted teeth only were investigated. On the

first visit a radiograph was obtained and the tooth isolated with a rubber dam, the crown being repeatedly swabbed with 70% alcohol. The pulp canal was opened with a sterile rose-head bur in the usual way, from the palatal aspect. The tip half of a sterile paper point moistened with nutrient broth was introduced into the canal and then dropped into a sterile test-tube. A second paper point was then introduced into the canal and dropped into 10 c.cm. of sterile broth. Having thus obtained material for the bacteriological investigation, the pulp canal was cleared mechanically with sterile instruments and reamed to a satisfactory size.

Penicillin was introduced into the pulp canal by saturating sterile absorbent paper points in a solution containing 20,000 Oxford units per c.cm. It was found that, on an average, approximately 50 units of penicillin was introduced with each dressing, which was sealed by a layer of sterile wax, followed by zinc oxyphosphate cement, wax being used to prevent any destruction of penicillin by the cement (zinc oxide with eugenol was observed to destroy penicillin completely); and the above procedure was repeated, usually at 48-hour intervals for the second and subsequent visits, if the organisms were found sensitive to penicillin, otherwise a tricresol dressing was substituted.

The sterile test-tube containing a paper point and the second test-tube with a point in broth were sent to the laboratory, where the following investigations were made.

The first point was withdrawn with sterile forceps and rubbed over a blood-agar plate while a sterile iron strip was introduced into the tube of broth to provide conditions in which both aerobic and anaerobic organisms will grow, cultures being incubated at 37° C. overnight. The direct plating gives a rough quantitative result of the organisms present, while the broth is a more sensitive test for both aerobic and anaerobic organisms—growth of the latter being possible in the presence of the metal strip. Subcultures were made from the broth aerobically and anaerobically to confirm sterility and to carry out penicillin-sensitivity tests on organisms grown.

Results

A case was not considered sterile until a minimum of three consecutive sterile results were obtained; in some cases up to seven consecutive sterile results at 48-hour intervals were obtained, while in others, as a more stringent test of sterility, a sterile point was sealed in the pulp canal for a week and used to inoculate a tube of broth.

Twenty-three cases were treated; with 3 of these no organisms were cultured, and the condition was possibly the result of aseptic gangrene of the pulp. The remaining 20 cases comprised 16 with chronic periapical osteitis, 3 with an acute suppurative inflammatory process superimposed on the latter, and 1 with an acute periodontitis resulting from gangrene of the pulp.

The following organisms were grown from the original paper points in the 20 cases examined: *Str. viridans* (17); non-haemolytic streptococcus (3); beta-haemolytic streptococcus (2); anaerobic streptococcus (1); *Staph. pyogenes* (2); *Staph. albus* (1); *Bact. coli* (3); *B. subtilis* (2); *Ps. pyocyanea* (2), and *Saccharomyces* (1).

It should be noted that in 11 cases a mixture of two organisms was grown: of course, in these cases the infection of the periapical tissue might well have been caused by a single organism, the secondary infection of this tissue depending on the relative invasiveness of the bacteria in the pulp canal.

Individual insensitive strains are often found in groups of organisms which are in general sensitive, and sensitive strains are known to become insensitive when the dosage of penicillin is small. Although the latter point was not observed, in 3 out of 17 cases the original culture of *Str. viridans* proved to be insensitive to penicillin. Insensitive organisms were finally found to persist in 11 cases, and these were therefore treated with tricresol; 10 of them were sterilized after an average of 5 weekly dressings. Of the remaining 9 cases only one was sterilized with penicillin; the remainder received dressings at regular intervals varying from 48 hours to one week without becoming sterile. One case received weekly dressings for 4 months, and on each visit a *Str. viridans* sensitive to penicillin was grown in pure culture. The case rendered sterile with penicillin had an acute periodontitis not related to a chronic inflammatory process of the periapical tissues and required 7 penicillin dressings at intervals of 48 hours before sterility was obtained.

Discussion

The problems met with in the treatment of infected non-vital teeth with associated chronic periapical osteitis are very similar to those presented by chronic bone infection in orthopaedic surgery. In both cases infected and, maybe, necrotic bone is present which is not easily accessible; and a further complication in pulp-canal therapy is the deliberate retention of these dead or relatively non-vital tissues. Robertson (1944) concluded that the local application of penicillin in cases of chronic bone infection has so far been disappointing, and cites three factors which appear to be responsible: (1) failure of continuous application; (2) inaccessibility of bone infection; (3) presence of dead bone.

Considering these points in relation to pulp-canal therapy, it is seen that:

(1) *Failure of continuous application* is equally applicable with the additional factor that as space is limited the amount of penicillin which can be applied must necessarily be small.

(2) *Inaccessibility* is certainly the case in dental pulp infections, since penicillin must diffuse through the apical foramina before the infected periapical tissues are reached.

(3) Whereas *necrotic bone* is not very commonly met in periapical osteitis following gangrene of the pulp, the cementum is often denuded of periodontal membrane, and when this occurs the source of its nutrition is cut off and the result is necrotic cementum. Cementum is histologically very similar to bone, and dead cementum is comparable to a sequestrum. Mowlem (1944) says that "penicillin is unlikely to give bacteriological control in the presence of sequestra," and the findings of this investigation confirm those of orthopaedic surgeons. One case out of 20 responded to treatment with penicillin alone, and radiographically no destruction of periodontal membrane was seen, so that it is just conceivable that no necrotic cementum was present.

The results of this investigation show clearly that penicillin administered as described is of little use in the treatment of infected non-vital teeth. Not only were half the cases ultimately infected with insensitive organisms but even those that were sensitive failed to respond to penicillin treatment.

We would emphasize that there has been insufficient condemnation of the practice of sealing into pulp canals organisms of unknown virulence and invasiveness. Adequate bacteriological control of pulp therapy is possible only through co-operation between the dental surgeon and the bacteriologist, and a satisfactory technique need entail no extra effort from the dental surgeon. Finally, any co-ordinated pathological service should be available easily and cheaply to dental surgeons as well as to medical practitioners.

Summary

A technique is described for the bacteriological control of dental pulp infections.

Of 20 cases examined 17 proved to be infected with *Str. viridans*; 14 of these strains were sensitive to penicillin.

In each dressing 50 units of penicillin were used, and dressings were done at 48-hour intervals.

Only one case was sterilized by penicillin, 7 dressings being necessary.

Eleven cases were infected with organisms which were insensitive to penicillin, and these were treated with tricresol, applied at weekly intervals. Sterility was obtained with an average of 5 dressings.

Eight cases continued to give cultures of an organism sensitive to penicillin even after prolonged treatment with this antiseptic, and these were finally treated with tricresol.

The similarity in the results of this investigation and those found in cases of chronic osteomyelitis treated with penicillin by orthopaedic surgeons is noted.

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