nerves and sacral parasympathetic nerves; it must be realized that over-activity of the one or under-activity of the other might produce the same result; and, indeed, Adamson and Aird have produced the condition in animals by dividing the parasympathetic nerves to the distal colon. Of neurogenic hypotheses mention may be made of spasm of the internal sphincter (Fenwick), achalasia of the sphincter ani (Hurst), and incoordination of the musculature of the colon, so that it does not relax before a peristaltic wave (Hawkins).

My own view is that the colon does not behave as if a terminal obstruction were present, for in such cases surgeons are accustomed to depend on early distension of the caecum as a constant diagnostic sign, and this is inconstant in megacolon. Adamson and Aird (1932) put the incidence of the disease as pelvic colon alone 37 per cent., with dilatation of the upper part or the whole of the rectum in 34 per cent. of cases. In only 25 per cent. does the dilatation extend to the ileo-colic valve, and in the remainder the descending, transverse, and ascending colon are involved with decreasing frequency. Radiological observations on the barium-filled colon show that it is active, although its activity is without result and may even give the impression of being purposeless.

My opinion at the moment is that the whole picture points to the presence of local segmental neuro-muscular incoordination when the disease does not involve the rectum, and that when the rectum is dilated there is added achalasia of the sphincter ani internus.

Treatment.—It has been shown by Morton and Scott (1930) that after spinal anaesthesia the colon may be able to evacuate its contents. As this procedure paralyses parasympathetic as well as sympathetic nerves one must conclude that the intrinsic neuro-muscular mechanism is adequate in such cases. In less severe types, preliminary enemata, training of the bowel, and the administration of liquid paraffin are usually adequate if the patient (and the parents) are intelligent and co-operative; when the rectum is involved, graduated dilatation of the internal sphincter, as suggested by Hurst, may also be usefully employed. When such simple measures are not effective the operation of sympathectomy may be considered, with the purpose of depriving the distal colon of its inhibitory nerves. Of the many technical procedures suggested, by far the most eclectic is that devised by Telford and Stopford (1934), and I consider that it should be employed exclusively. It consists in the resection of the mesially directed branches of the lumbar ganglia from the second to the fourth inclusive, and avoids the paralysis of the vasoconstrictor nerves to the legs which follows the (equally efficacious) removal of the lumbar cords, and the sterility which follows resection of the presacral nerve in male patients.

The results of sympathectomy are distinctly good; in the series collected by Ross (1935), twenty-one out of twenty-nine patients were benefited, and many other surgeons have reported successes. My own experience is similar. The mechanism of the improvement is obscure. Any explanation must take into account the often dramatic immediate improvement in function, which disposes of valves, kinks, or elongations as the essential cause of the failure of evacuation of the colon. Indeed (and this emphasizes the point made by Hurst), there is often little change in the appearance of the colon after a barium enema, though its function is satisfactory. I do not think one can go further than to say that the distal colon, under the unbalanced dominance of its extrinsic motor nerves, regains its physiological adequacy. It is interesting to note that when the urinary tract is dilated it

shares in the improvement following sympathetic neurectomy (Adamson and Aird, personal experience).

Conclusion

In conclusion I advance as a basis for this discussion the view that elongation and dilatation of the colon are not primary causes of dysfunction of the colon, but incidental findings; and that their surgical correction should never be attempted. The condition of megacolon is an exception, in which the dilatation and elongation are part of the disease. It may be possible to persuade a megacolon to function adequately by medical treatment; if this fails, sympathetic neurectomy is likely to be successful.

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PULP-SPACE INFECTION

BY

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In the past attention has been drawn to the treatment of septic fingers and hands, notably by the works of Kanavel, Fifield, and Eckhoff. In attempting to follow their teaching I have collected the details of 183 cases of sepsis in the hand, among which were fifty-one of pulp-space infection. An account of my practice and treatment, with results and analysis of these cases, is here given.

Anatomy

In order to appreciate the difficulties met with in the treatment of pulp-space infection it is necessary to review certain fundamental anatomical points. The skin on the volar aspect of the finger is bound down to the periosteum on the front of the terminal phalanx by the dense fibrous tissue strands. The pulp is composed of fat, and is divided by the dense connective tissue framework into a series of loculi. Sweat and sebaceous glands lie in the fat, their ducts passing outwards to the epidermis.

Infection in many cases can be traced to a breach in the continuity of the skin, and is confined to one or a number of loculi in direct relation to the nidus of infection. An infection of these loculi tends to be directed backwards towards the periosteum of the terminal phalanx. Generalized involvement of the pulp is checked until the later stages by the fibrous walls. Inflammatory swelling, held within the limits of firm-walled loculi, is associated with greatly increased tension in the pulp, causing pressure, with diminished blood supply to the pulp and bone.

Classification

There are five main types of pulp-space infection, the classification depending on the time at which they are

seen and the site of infection. These cases may be grouped as terminal, lateral, and central infections. The central cases comprise those which are early and just

FIG. 1.—Showing the five main types of pulp-space infection.

beneath the skin and those which are late and the infection has passed deeply into the pulp. With neglect or inadequate treatment cases are seen in which the whole pulp has undergone disorganization; in many the terminal phalanx is dead, in part or the whole.

The series of fifty-one cases is grouped as follows: terminal, 4; lateral, 5; central—(a) superficial 5, (b) deep 27; late, 10 cases.

Aetiology

Of the fifty-one cases twenty-six knew of no cause, while of the remaining twenty-five, ten had sustained a small cut or roughening of the skin covering the pulp space. Ten knew definitely that they had had a piece of steel or a thorn in the finger, while four attributed the condition to receiving a blow on the finger; one case followed a burn.

Occupation.—Thirty-eight patients were working at a trade when they became infected. In this series four cases occurred in school children. The following table is compiled from the data available.

	Females	Males
Working in a trade	17	21
Not working, including housewives	12	1
	29	22

It is said that butchers, cooks, bakers, and fishmongers are prone to infection. In this series only five patients followed these occupations, whilst machine hands numbered twenty-two. Eleven others were of different trades, including carpenters, a glass polisher, a leather worker, and a typist. In a modern industrial town such workers constitute a majority.

The right hand was involved in twenty-six cases and the left in twenty-one. The thumb and index finger were most often affected. The digits involved were as follows: thumb, fifteen; index finger, fifteen; middle finger, six; ring finger, six; and little finger five times. There is no record in the remaining four cases.

Diagnosis

Early diagnosis of pulp-space infection must be established with certainty before making a radical incision necessary to obtain adequate drainage.

Symptoms.—Aching is the first indication to the patient that all is not well with his finger. He may realize that a trivial cut or one that has healed is about to give rise to further trouble. In twenty-five cases with a known cause the onset of symptoms followed the injury in the following times:

No. of Days	1	2	3	4	6	8-11
No. of Cases	9	2	4	3	2	5

Aching is first noticed when pressure is applied to the end of the finger; later it arises spontaneously and is present the whole time. Very quickly the pain becomes throbbing in character and the patient is incapable of sleep. In this series throbbing and inability to sleep have been taken as cardinal symptoms, and, with the presence of these, in only two cases was pus not found.

Physical Signs.—The pulp of the finger becomes swollen; swelling and induration are appreciable in comparison with the pulp of the corresponding finger of the other hand. In early cases a hyperaemic blush is found round the edge and base of the nail on the dorsum of the involved finger. Later the palmar aspect of the digit may become red and hot, but this is not an invariable finding. Tenderness is an indication of the part of the pulp space involved and the site of early pus formation. It is located by pressing on the pulp with a small probe. Induration is the cardinal sign of inflammation in the pulp, with the disappearance of normal fluctuation. Later with softening, and disorganization of the pulp architecture, fluctuation reappears. The case must be treated before the onset of fluctuation, for at this stage the phalanx is dead.

Treatment

Lancing.—The type of incision described as “lancing” is a vertical incision made in the length of the infected pulp space along its volar aspect. The length of the incision depends upon the courage of the patient and upon the determination of his doctor. Only those loculi in the line of the incision are opened, while those on either side remain inadequately drained. The patient feels some relief, but the finger continues to discharge. Early cases or those in which the infection lies just beneath the skin may be adequately treated by this incision. In hospital practice few cases of this type are seen, and it is therefore difficult to estimate the depth of the infection and to recognize the cases suitable for this treatment. When this incision is deemed to be the correct one it is urged that if resolution does not take place within twenty-four hours a further radical incision should be made. In twelve cases which were lanced a second operation was performed immediately it was realized that the treatment was inadequate. In five of these necrosis of the terminal phalanx did not occur; in five others a sequestrum was demonstrated on radiological examination and sequestrectomy performed; and in the remaining two a further operation for the removal of dead bone was carried out.

The U-shaped Incision (Fig. 2).—A curved incision is made round the end of the finger in front of the nail, cutting back into the pulp space, but never further than within half an inch of the distal skin crease, in order to avoid opening up the flexor sheath and so converting the infection into a tenosynovitis. By this method adequate drainage is obtained, and if performed early no complications arise.

FIG. 2.—Showing the U-shaped incision for cases of terminal infection.

The incision is slow to heal, and does not leave an even scar. With experience of these disadvantages I ceased to employ this incision for the treatment of central infection. The U-shaped incision is the proper treatment for cases of terminal infection. The depth of the incision

is governed by the extent of the pathological changes found at operation.

Transfixion Operation (Fig. 3).—Two incisions are made, one on each side of the affected finger, 2 mm. in front of the edge of the nail, and the knife is passed across the pulp space just in front of the terminal phalanx. The incision extends to within a quarter of an inch of the end of the finger, and proximally to within half an inch of the distal volar crease. By this means all the fibrous tissue septa are divided posteriorly and all the loculi laid open. The palmar aspect is not turned back as a flap, and deformity and slow healing are avoided. There is no terminal scar over the sensitive pulp.

The full transfixion operation is recommended in early cases of central infection because it is impossible to assess the depth to which the pus has travelled backwards. If pus is not found, then with the knife in the transfixion incision cuts are made forwards into the pulp until pus is reached; care should be taken not to perforate the skin. In cases of lateral infection it is necessary to open only one side of the finger.

FIG. 3.—The transfixion operation.

Of the series of fifty-one cases this operation was carried out in thirty-three, and in only two did sequestrum formation occur.

Operative Technique

In hospital practice the infected finger is cleaned with spirit and a sterile towel is placed over the rest of the hand and forearm. Sterile gloves are worn and the patient anaesthetized with nitrous oxide. When a sufficient depth of anaesthesia is reached an assistant applies a tourniquet to the arm. The incisions recommended are then made; the knife is thrust through the pulp space from one lateral incision to the other, with the back of the knife facing proximally to avoid inadvertently opening the flexor sheath.

FIG. 4.

To transfix the pulp space in this way is not an easy matter owing to the toughness of the fibrous tissue. The tourniquet is essential to obtain a bloodless field. It is immediately realized when pus is reached, and if this is not seen the additional incisions described can be made. The pus is mopped away and sinus forceps are pushed into the incision so as to draw a piece of narrow glove-drain through. A magnesium sulphate dressing is applied with a covering of cotton-wool and a tight bandage is placed over all. The tourniquet is now released and the patient allowed to return to consciousness.

After leaving the operating table he is rested for ten minutes, at the end of which time blood has soaked through the dressing, necessitating a further application of wool and bandage. The amount of haemorrhage from the incision into the vascular pulp is considerable, but by adopting this method the bleeding is controlled and the patient is able to return home.

Anaesthesia

It is important to use an anaesthetic which allows sufficient time to conduct the operation, without hurry, along the lines indicated; clear vision and a controlled patient are essential.

Gas-inhalation anaesthesia (nitrous oxide) was employed throughout this series: I believe that it gives full satisfaction. Ethyl chloride local anaesthesia was not used. The main objections to this are:

1. Frozen tissue is extremely hard, and it is impossible to make a satisfactory incision until the tissues commence to thaw.
2. Severe pain accompanies the great pressure necessary to cut through the hardened tissue and tends to check thorough treatment. When pus lies deeply it may not be reached.
3. It is impossible to carry out the transfixion operation with ethyl chloride local anaesthesia.
4. It is probable that the process may predispose to further tissue necrosis.

Adequate local anaesthesia can be obtained by digital nerve block at the base of the finger with 2 per cent. novocain infiltration. Local anaesthesia is contraindicated in cases in which the infection has spread beyond the pulp space.

After-treatment

The patient is seen next morning and the finger dressed. Care is taken to leave the rubber drain in position. A fresh magnesium sulphate paste dressing is applied and a short wooden finger-splint incorporated in the dressings. After forty-eight hours the rubber drain can be removed without discomfort and a further dressing given. In cases in which little pus was found the drain is left in for three days. In from four to six days elastoplast dressing is applied; this is kept on, according to the amount of discharge, until soiled. The patient attends at three-day intervals. When tissue destruction is marked separation of necrosed fibrous tissue may take at least three weeks. With elastoplast dressings the wound does not heal until separation is complete.

It is not my practice to use hot baths or fomentations. Hot fomentations had been given in many cases before the hospital treatment. Eckhoff condemns fomentations in the following terms: "The finger does not appear to be getting daily much worse, and the pain is disguised by counter-irritation in the form of hot bathing, hot fomentations, poultices, and other fatal local applications. These I would condemn at the outset. Bathing with or immersion in hot water only leads to generalized redness and tenderness of the finger, which makes diagnosis more difficult and is no lasting comfort to the patient. Fomentations and poultices tend to scald the part at first, and soon get cold and wet, and only serve to increase oedema when applied for more than twenty-four to forty-eight hours, and to spread infection, especially if there is already an open wound." It is my experience that in pre-operative treatment fomentations are of little value and lead to procrastination, and that infection subsides readily with adequate drainage.

The general toxæmia present cannot be ignored and must receive full treatment. The limb is splinted and carried in a sling, and in all cases the patient is advised to cease work and to rest in bed or in the garden. A large fluid intake, from ten to twelve pints daily, is of advantage until resolution is taking place.

Complications

Pulp-space infection must be treated seriously in the early stages before complications arise. Complications are difficult to treat and local deformity is unavoidable. When infection has spread beyond the pulp it may be impossible to check its course. The infection may pass to the tendon sheath, to the hand and palmar bursa, and in advanced cases to the space of Parona in the forearm. Many operations may be required to deal with these complications; amputations and contractures may cripple the patient or impair his working capacity. In unfavourable cases in the presence of virulent organisms, lowered resistance, or protracted course, life may be endangered by general toxæmia or systemic invasion by organisms. In this group of fifty-one cases complications remained local, and this paper is confined to the experience gleaned from these.

Sequestrum Formation

Sequestrum formation must be suspected in all cases in which the infection is of long standing or in which discharge persists. Ten cases of sequestrum formation were met with; of these seven had been lanced when seen, one came up with a sinus, one had discharged spontaneously, and one had been opened by a lateral incision. In the seven cases I believe that sequestrum formation resulted from inadequate drainage at the initial operation, further treatment having been postponed in spite of non-resolution of infection.

In hospital practice cases are referred in which the finger has failed to heal or discomfort and unfavourable progress continue after a preliminary operation. On examination a small wound may be found, and the finger is cyanosed, bulbous, and tender. In chronic cases the wound may be lined by granulation tissue and there is a constant discharge. In the chronic cases, or those in which satisfactory progress does not occur following the preliminary operation, it is essential to have the fullest possible understanding of the underlying pathological changes. A radiograph of the finger must be obtained, lateral and antero-posterior views. The findings must be interpreted with caution. The bone may be rarefied or absorbed in part, but such findings do not call for a surgical attack upon the phalanx, and at this stage adequate drainage may be provided and the bone left alone. Further radiographs must be taken from time to time and the bone watched. A fracture may occur across the base of the phalanx. In children the diaphysis may separate from the epiphysis. Bone erosion or sequestrum formation involves the shaft of the phalanx, and a small area of bone adjacent to the articular surface tends to survive. In this small fragment the flexor tendon is inserted. Sequestrum formation may take place in part or the whole of the phalanx. The dead bone retains its normal density and structure, and is sharply defined. These features form a striking contrast to the adjacent bones, which may have undergone absorption, causing changes in density and definition in the normal architecture. In later cases the terminal interphalangeal joint may be involved and diminution of the joint space or erosion of the adjacent bones may be seen.

Treatment.—The treatment of pulp-space infection complicated by sequestrum formation is governed by the degree of destruction of the involved phalanx. Bone destruction is revealed by the radiograph and by observations during the course of operation. When the radiograph shows a normal terminal phalanx except for a small sequestrum lying on the volar aspect, or the phalanx is eroded, the treatment consists in ensuring adequate drainage by the transfixion operation. The sequestrum is removed, or the phalanx scraped with a small spoon. Care must be taken to avoid the region of the base of the phalanx in which the flexor tendon is inserted. If the case is further advanced and the radiograph shows very extensive changes at the base of the diaphysis, with fracture, and the base of the phalanx is normal, treatment consists in adequate drainage by lateral transfixion; the whole of the terminal part of the phalanx is removed, the small proximal fragment, or in the child the epiphysis, is left to avoid infection of the interphalangeal joint and the flexor sheath. In very neglected cases in which there is involvement of the whole phalanx, including the terminal interphalangeal joint, the complete phalanx is removed through the transfixion incision. In cases in which the flexor sheath is not involved removal of the whole phalanx at this stage, carried out with care, does not add the risk of spread of the infection, because the flexor sheath may be shut off by adhesions.

Tenosynovitis

Tenosynovitis is a disaster of the first magnitude. It is bound to be followed by a prolonged convalescence, with a stiff and deformed finger, and in less favourable cases a crippled hand. The condition may arise from the natural spread of infection, but in practice this does not constitute the most important cause. In the majority of cases it follows in the wake of some surgical intervention. Spread of infection may be precipitated early in the case by extending an incision for drainage of the pulp too far proximally and opening the tendon sheath inadvertently. In later cases tenosynovitis is a complication arising from the treatment of sequestrum formation. It has been stressed in the treatment of cases associated with radiographic changes in the terminal phalanx that careful discrimination must be exercised before interfering with the bone at operation. In cases in which dead bone cannot be demonstrated it is better to provide adequate drainage and to review the case later. In the adult the base of the distal phalanx must be preserved in order to avoid opening the interphalangeal joint and flexor sheath. The base of the distal phalanx must only be removed in cases in which there is infection of the joint or tenosynovitis is present.

REMOVAL OF PHALANX,
OPENING OF TENDON SHEATH
FIG. 5.

In cases seen following removal of the base of the phalanx a certain amount of drainage is provided through the tendon sheath being open at its extremity, and infection may remain localized to that part of the flexor sheath opposite the middle phalanx. When the flexor sheath is involved the patient is unwilling to move the affected finger, which becomes red, swollen, and slightly flexed. In two cases a small sinus discharging a thin serous fluid was seen at the distal skin crease. When the diagnosis of tenosynovitis is established lateral drainage must be provided immediately. A dead tendon must be excised

at a subsequent operation. In women and such men as desire it the finger may be conserved, but for the subject employed in manual labour better function may be obtained by amputation.

Summary

1. This paper is based on the experience gained in the study of 183 cases of infections of the hand, of which fifty-one cases were pulp-space infections.

2. Aching followed by throbbing and inability to sleep, associated with induration of the pulp, should be the established indications for immediate operation in pulp-space infection.

3. With adequate drainage inflammation in the pulp readily subsides. If resolution is delayed it is urged that the transfixion operation should be carried out.

4. Complications in pulp-space infection can be prevented by providing adequate drainage in the early stages.

5. In a chronic case it is essential to employ radiological examination before proceeding to treatment.

6. In the treatment of sequestrum formation and the prevention of tenosynovitis it is necessary to employ care in operation, and if possible to conserve the base of the distal phalanx.

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The annual meeting of the British Association will be held at Nottingham from September 1 to 8 inclusive, under the presidency of Sir Edward Poulton. Thirteen Sections have been arranged—namely, mathematics and physical sciences, chemistry, geology, zoology, geography, economics, engineering, anthropology, physiology, psychology, botany, educational science, and agriculture. Presidential addresses of medical interest are as follows: Dr. G. W. C. Kaye, noise and the nation; Dr. F. L. Pyman, chemotherapeutic research; Professor F. A. E. Crew, the sex ratio; Dr. J. H. Hutton, Assam origins in relation to Oceania; Dr. E. P. Poulton, new views on metabolism and nutrition, and growth in man; Dr. Mary Collins, tests in common use for the diagnosis of colour defect; and Mr. H. G. Wells, the informative content of education. Other sectional discussions will relate to the contribution of physiology to the health of the individual and the community, protein chemistry, recent advances in genetics and cytology, motor vehicles and road safety, and the national food supply. Professor H. Hartridge will deliver a public lecture on illusions of colour. Further information about the programme of meetings, excursions, and accommodation in or near Nottingham may be obtained from the secretary, British Association, Burlington House, London, W.1.

ENTERIC FEVER★

BY

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I must begin by emphasizing that I speak only from the standpoint of a practising medical officer of health. In consequence most of what I have to say must appear somewhat elementary—a reiteration of what is already well known. But administration is mainly concerned with the application of established principles in changing circumstances, and the principles governing the prevention of enteric are no longer in doubt. Although many points of detail still await elucidation, our practical problem is the efficient utilization of the knowledge we already possess.

Reduction of Incidence and Mortality

It is not necessary to adduce statistical evidence as to the great diminution in the incidence of enterica in recent years. When a death rate drops, more or less steadily, from 388 per million in 1870 to 4 per million in 1935 there can be no serious doubt that the disease is becoming less common. Nor are statistics necessary to establish what is within the personal knowledge of senior members of the profession. A generation or two ago enteric was familiar to everyone in practice. To-day it is almost a clinical curiosity: there are many practitioners of standing and experience who have never had occasion to diagnose or treat a case.

But if enteric in its endemic form is no longer a constant menace, it is still capable of manifesting itself on occasion in formidable epidemics. The greatest water-borne outbreak on record—that which occurred at Barcelona and caused 1,847 deaths—was no further back than 1914. The outbreaks at Pforzheim in 1919, at Hanover and Rostoff-on-Don in 1926, and at Lyons in 1929 were all epidemics of the first magnitude, affecting thousands of people, while so recently as 1927 Montreal experienced a milk-borne epidemic, wherein 5,002 persons were infected and a tenth of them died. We have fortunately escaped tragedies of such dimensions, but sufficient outbreaks have occurred in recent years to remind us that enteric is still to be reckoned with as a serious problem in public health.

There is not much room for doubt as to the conditions which have determined the reduction of its incidence. Of no other infective disease can we say with the same confidence that sanitary activities have completely justified themselves. There is no reason to suppose that, in the absence of those activities, enteric would not be as prevalent to-day as it was in the middle of the last century. There is no evidence to suggest that it is less virulent or less capable of spread in a susceptible community, or that herd immunity to infection is greater than in former times. An almost savage scepticism is essential to the sanitarian, who is constantly tempted to believe that improvements in health are the result of his efforts to bring them about; but in this connexion scepticism appears misplaced.

The diminution of mortality, so far as Great Britain is concerned, came in three stages. From the early seventies it fell fairly steadily till 1885. From that date till about 1900 there was little improvement. At the

* Read in opening a discussion in the Section of Hygiene and Public Health at the Annual Meeting of the British Medical Association, Belfast, 1937.