

Original Articles.

STUDIES IN DRACONTIASIS.

PART VI*.

By N. HAMILTON FAIRLEY, O.B.E., M.D., M.R.C.P.,
D.T.M. & H.

Medical Research Officer, Bombay Bacteriological Laboratory, Consulting Physician to the Sir Jamsetjee Jeejeebhoy and St. George's Hospitals, Bombay.

MECHANICAL AND SURGICAL EXTRACTION.

In order adequately to treat guinea-worm disease by mechanical or operative interven-

3. The ulcer is presenting with the central orifice of the sinus.

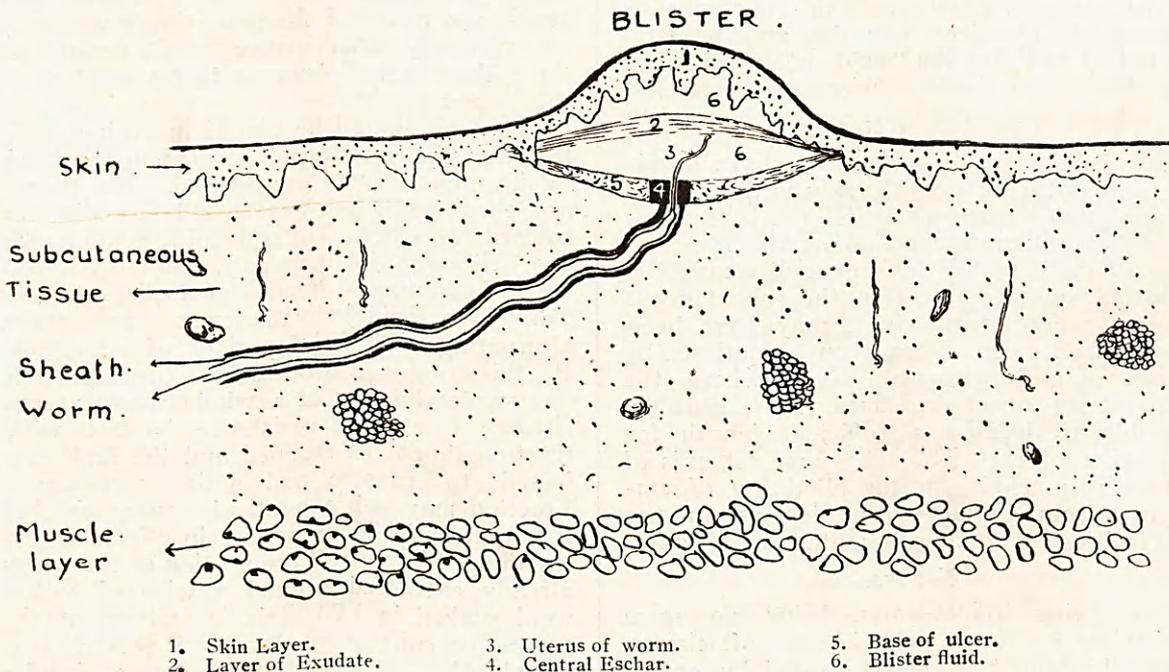
4. The worm is closely convoluted, occupying a limited area of tissue.

5. Secondary infection and septic complications have ensued.

In a preceding publication by Fairley and Liston (1924), the structural relationships of the worm have been dealt with and a perusal of the accompanying line drawing will suffice to illustrate these details, including the intimate relationship existing between the parasite and its fibrous tissue sheath and the tortuous course followed by the pregnant female worm, which may sometimes penetrate deep fascia, muscular planes or joint cavities.

PLATE I.

Diagrammatic drawing of worm in relationship to human tissues.



- | | | |
|----------------------|--------------------|-------------------|
| 1. Skin Layer. | 3. Uterus of worm. | 5. Base of ulcer. |
| 2. Layer of Exudate. | 4. Central Eschar. | 6. Blister fluid. |

tion, both the structural relationship of the worm and the special etiological agent or agents (the female worm, embryos or secondary bacterial invaders) concerned in the production of the pathological condition present must be appreciated. The mode of treatment varies according to the stage of evolution of the pathological process and as to whether—

1. The worm is located prior to blister formation.

2. A blister is present.

If the correct principles underlying mechanical extraction are to be applied in practice, these factors must be taken into account. Thus relaxation of the group of muscles in immediate relationship to the worm, massage along the course of the sheath, and *intermittent* in contradistinction to continuous traction are indicated as rational measures in any effort at mechanical removal. Again, once the worm has communicated with the exterior, the existence of skin cocci on the surface of the sinus modifies all forms of treatment. During mechanical extraction breakage of the elastic worm is followed by its retraction and disappearance into its sheath in the subcutaneous tissues. Adherent cocci are in this manne-

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introduced. Embryos also escape from the broken uterus of the female worm; inflammatory exudation and plugging of the canal ensue. Secondary abscess or cellulitis is the result. In treating guinea-worm disease the importance of carefully cleansing and applying antiseptics to the ulcer and central sinus and of subsequently covering the parts with sterile dressings cannot be overestimated. For the former purpose a solution of carbolic acid (1 in 20) is most useful. When secondary infection with sepsis has occurred a solution of hypertonic saline (5 per cent.) and sodium citrate (1 per cent.), as advocated by Turkhud (1919), is of real value. The ordinary iodine toilet of the skin is used preparatory to operation.

LOCALISATION OF THE WORM.

One of the main difficulties in any operative procedure is the accurate demonstration of the course of the worm in the subcutaneous tissues. In obscure cases this may be facilitated by utilising the "cold reflex" or when available special X-ray techniques.

THE "COLD REFLEX."

On applying ice or preferably ethyl chloride by means of a spray to the skin in the vicinity of the guinea-worm there follows within one minute a reflex contraction of the musculature of the female which generally makes it palpable and prominent in the subcutaneous tissues where formerly it may have been invisible. Its course can then be outlined by means of a flesh pencil. Even where the whole worm cannot be defined, it is generally possible to localise a sufficient length for operative intervention. The same reflex is of course responsible for the liberation of embryos from guinea-worm lesions in the extremities on coming in contact with water.

X-RAYS.

The living guinea-worm, being no more impervious to X-rays than human soft tissues, naturally cannot be demonstrated by ordinary X-ray methods. Recently Hudellet (1919) has advocated the injection of 10 per cent. collargol into the body of the worm by means of a special needle and syringe in order to render it opaque to X-rays. By this means the worm may be located throughout its course in the tissues. Undoubtedly where X-ray plant is available this procedure will repay the additional trouble involved in those cases where it is not possible to outline the parasite by more simple means.

Radioscopic examination of dead calcified worms has been advocated by certain French surgeons, notably Dimier et Bergonie (1918) and in India by Powell Connor (1918) who stresses the importance of the moniliform convoluted shadow in diagnosis. The superficial location of the parasite suggests that

therapeutic application of X-rays might be effective in the treatment of early cases but no observations appear to have yet been made on this subject. This is all the more remarkable as Faulkner (1883) forty-one years ago employed electrolysis in the treatment of this disease.

MECHANICAL MEANS OF EXTRACTION.

Of the various mechanical means of extraction the most commonly employed and the one Manson (1905) was inclined to recommend consists of water douching until the embryos are discharged and the subsequent winding of the worm around an ivory peg, slight traction only being employed. This method has undoubted advantages, for, while it is extremely slow the risk of secondary infection is minimised, especially when sterile dressings are applied. I prefer the use of ice or ethyl chloride spray for evacuating embryos, and provided the practitioner will take the necessary manipulative care, recommend the following technique as being superior to the former method:—

The limb should be placed in such a position that the muscles in the area of the track of the guinea-worm are relaxed. The tissues are then massaged, pressure being directed toward the ulcer. Oil is helpful in diminishing friction. Simultaneously, with the other hand *intermittent traction* is applied to the worm by a rapid jerky movement of the wrist, alternating with brief periods of relaxation. By this combined process it is often possible to completely extract a whole worm at one sitting. If marked resistance is met with, traction should be stopped and the limb subjected to passive and active movements. Traction may subsequently be successful but if not, it is futile to persist in efforts at extraction. Simply roll the portion of the worm already extracted around a wisp of cotton wool soaked in 1/20 carbolic and repeat the process on subsequent days until extraction is completed. At each sitting reflex ejaculation of embryos is produced by an ethyl chloride spray. It is important before starting intermittent traction and during the course of treatment to clean the ulcer base and sinus with 1 in 20 carbolic daily and to keep the part covered with sterile dressings. Breakage of the worm under these conditions is much less likely to be followed by secondary abscess, which is almost invariably due to bacterial infection. The disadvantage of this method lies in the duration of the treatment, but it should certainly always be attempted if communication with the external surface has occurred. Amongst other mechanical modes of treatment may be mentioned that adopted by Pisani (1891) who advocated weight extension. A weight of from 4 to 6 drachms was attached to the parasite according to its

thickness and continuous traction was applied in this fashion.

SURGICAL TREATMENT.

(1) *When the worm is located prior to blister formation.*—Under these circumstances the special operative procedure described later, which is conducted under cocaine and adrenalin anaesthesia, affords most satisfactory results. By such a measure the worm can be extracted completely and the incision healed by primary intention within a few days. It must be remembered that mechanical rupture of the worm at this stage (i.e., prior to blister formation) is very liable to be followed by urticaria, whereas once the blister has been formed the writer has never observed this complication follow such an accident. The significance of this observation is readily appreciated when one remembers that urticaria and the local blister respectively represent generalised and local reactions to some toxic substance produced by the adult female worm.

Case No. 104.—A youth, aged 19 years, working in the Share Bazar stated that he was in the habit of drinking water obtained from a well in Elphinstone Circle, Bombay. Twenty days previously he had noted a palpable guinea-worm on the inner side of the right foot, but there had been neither urticaria nor blister formation. An incision was made over the worm, but when about twenty inches had been removed it broke across, the remainder retracting within the tissues. Sterile dressings were applied. Two and a half hours later the patient felt very sick but did not actually vomit. He went to bed feeling feverish and almost immediately urticaria appeared. The wheals were large and itchy involving the face, trunk and extremities and lasted for 1½ hours. The eyes were puffy. Next day there was oedema and swelling over the incision and microscopical examination of the exudate expressed from the incision showed pus cells and embryos. The patient made an uneventful recovery.

(2) *When a blister is present.*—Once a guinea-worm blister has been observed it is advisable to immediately paint the surface with tincture of iodine and to aspirate the blister fluid under aseptic conditions. By so doing the subsequent dimensions of the ulcer are reduced and the period of convalescence may be correspondingly shortened.

Frequently there is considerable local oedema around the blister and in consequence the worm may not be palpated. As this generally subsides within 48 hours, it is often wise to apply sterile dressings and postpone operating. If for any reason immediate intervention is called for, the skin of the blister and the layer of exudate should be removed with a pair of scissors. The base of the ulcer is then infiltrated with cocaine and adrenalin, and the worm exposed by incision where it lies curled in wavy fashion embedded in granulation tissue. Extraction may be then immediately commenced by the method of intermittent traction and massage. As a general rule,

however, operation yields more satisfactory results when the peri-ulcerous oedema has subsided.

Case No. 2.—A male, aged 45 years, stated that 5 days previously at 10 p.m. an itchy eruption appeared on the face and trunk lasting for 7 hours. He vomited three times and had looseness of the bowels, also attacks of giddiness and faintness. By morning these symptoms had disappeared but a small blister was noted associated with local itchiness. Four days later he came to the clinic for treatment. On examination there was an unruptured blister of some 2 cm. diameter on the right foot. As there was some swelling and oedema present and as embryos were required for experimental purposes, sterile dressings were applied after the skin and the gelatinous layer of exudate had been removed. Embryos were collected daily. Eleven days from the onset of the lesion the worm was found to be readily outlined and under cocaine and adrenalin anaesthesia it was completely removed through two incisions as afterwards described. Complete cure resulted, the incisions healing within seven days of operation. At no time did the patient suffer serious inconvenience from the local lesion and throughout treatment was able to continue his ordinary duties.

(3) *When the ulcer and central sinus are presenting.*—Once the blister has ruptured and an ulcer has formed, the indications are to keep its surface as sterile as possible and to extract the worm by intermittent traction and massage, either with or without operation. If the central whitish eschar in the base of the ulcer has sloughed away the head of the worm can generally be extracted by inserting a fine forceps into the central sinus. If the eschar is still intact it may be necessary to make a small nick over it with a scalpel. This will generally suffice to reveal the worm. Mechanical extraction by intermittent traction and massage is now attempted, but if not successful it is better to cocainise the tissues over the worm at some distance from the ulcer after localising it by palpation, the "cold reflex" or X-ray examination. Incision and extraction of the parasite by open operation is then performed.

(4) *When the parasite is closely coiled and localised.*—In a minority of cases the worm is closely coiled and localised to a limited area of tissue. Under such conditions the only satisfactory treatment consists of excision *en masse*. This procedure is of special value in such a region as the scrotum where it may be possible under local anaesthesia to remove the worm entirely, along with any indurated surrounding tissue. Healing occurs within a few days of operation.

(5) *Secondary infection and other complications.*

Secondary infection is generally associated with breakage of the worm and its withdrawal into the connective tissue sheath in the subcutaneous tissues. This accident may lead to distension of the sheath with purulent exudate and inflammation around the track of the worm. Often a long painful indurated

swelling is present. Cellulitis may result or more frequently a localised abscess forms somewhere along the track of the worm. The organisms mainly implicated are *S. aureus*, *B. coli* and streptococci.

When such a case comes to the clinic for treatment a probe is inserted along the sinus and sheath, the area frozen with ethyl chloride, and the intervening tissues slit up with a scalpel for a distance of $1\frac{1}{2}$ to 2 inches. Pressure is then applied along the indurated track commencing at its distal end. This pressure often results in pus spurting out in a definite stream and not infrequently the remainder of the worm will also be expelled in this simple fashion. If this is so cure will rapidly result. Where an actual localised abscess has developed, this should be incised and drained. Frequently the dead disintegrating worm also comes away during the process. Cellulitis is best treated by hot applications such as fomentations, antiseptic or hypertonic saline baths and free multiple incisions. Citrates and aperients should be administered per os. In all these septic conditions, citrated hypertonic saline has proved most valuable as a local dressing.

Case No. 3.—A male, aged 42 years, stated that he had never had urticaria but that one month ago he had a guinea-worm in the sole of the right foot. It had been broken across and an abscess followed. Then fifteen days later a worm appeared in the scrotum, only a small ulcer and sinus forming. The testicle became very swollen. For ten days he had suffered from severe fever and been confined to bed. On examination the patient looked sick. The pulse was 108, the temperature 100.6° F. and the tongue was furred. The scrotum was distended with pus which could be readily expressed through the sinus. *S. aureus* and a non-hemolytic streptococcus were cultured from it. The left testicle was very painful and enlarged, there being a definite epididymo-orchitis present. The cord was thickened and tender. A probe was inserted, the tissues frozen with ethyl chloride and the sinus slit up. Gauge drainage and citrated saline dressings were applied. The foot was treated in similar fashion, the sinus being slit up for 2 inches and multiple incisions made. The purulent discharge from the foot soon ceased and had healed in three weeks, but the scrotal incision was still discharging pus seven weeks after operation. The testicle and epididymis at this stage appeared normal except for a cord-like swelling which lay adjacent to the interior pole of the epididymis, becoming continuous with the indurated tissue surrounding the sinus. The patient made a complete recovery, and six months later no abnormality could be detected in the scrotum or testicle, except the scar of the previous incision.

Subacute sterile abscesses are occasionally met with, due to premature death of the female *D. medinensis* with liberation of embryos into the subcutaneous tissues. Here incision is really not necessary and aspiration of the brown sero-gelatinous pus will suffice to establish cure. The condition may be diagnosed by the presence of a deeply seated fluctuant swelling not communicating with the exterior and associated only with local subacute inflammatory reaction. On culture

the pus is sterile, while microscopical examination reveals numerous embryos and polymorphonuclear cells, many of which are eosinophiles.

Case No. 4.—A male, aged 22 years, stated that eleven days previously he had suffered from a generalised itchy rash which lasted 56 hours. Eight days ago a small blister appeared on the postero-superior aspect of the right leg. Efforts to extract the parasite resulted in breaking it across. Five days ago another swelling appeared over the left tibia. On examination there was a cellulitis involving the right calf with induration demarcating the track of the worm. Thick creamy pus was expressed from the sinus on pressure. Microscopical examination showed numerous neutrophile polymorphonuclear cells containing engulfed cocci and some mononuclear elements. Cultures showed *S. aureus*. After incision and drainage the remainder of the worm was discharged and healing resulted. The left tibia presented a localised deep fluctuant abscess not communicating with the exterior. Incision showed brownish sero-gelatinous pus which was sterile on culture, while microscopical examination revealed numerous embryos and polymorphonuclear cells, many of which were eosinophiles. No worm was demonstrable. Healing occurred after incision but subsequent experience has shown that aspiration would have sufficed to cure this condition.

The treatment of *synovitis* and *arthritis* follow ordinary surgical principles and need not be detailed. The exudation may be serous or purulent. Generally there is an associated cellulitis, the synovial membrane being involved by direct spread through adjacent tissues. More rarely the worm actually enters into the joint cavity.

Permanent deformities are invariably associated with sepsis and a history of prolonged illness in the recumbent posture and are dependent on contraction of tendons, peri-arthritis and fibrous ankylosis within joints. Bony ankylosis is a rarity. The joints mainly involved are the knee and ankle, while the tendo achillis and hamstrings are not infrequently contracted. Ordinary surgical treatment is indicated.

Calcified worms may be symptomless and under such circumstances call for no special treatment. In one case of this series a calcified worm entered the knee joint, piercing the synovial membrane; in another it involved the perineum, scrotum and epididymis. Powell Connor (1922) has recently made a notable contribution to our knowledge regarding the diagnosis and clinical manifestations of calcified guinea-worms. In his series of cases previous diagnoses of chronic rheumatism, traumatic synovitis, periostitis and sciatica had been made, where X-rays subsequently revealed calcified worms. He concludes that as a general rule excision is the right treatment, but this can be very difficult and in some instances the amount of disability may not justify an extensive dissection.

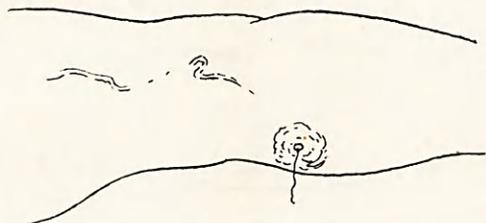
A NEW OPERATIVE TECHNIQUE.

Pestonji (1886) described the correct method of demonstrating and extracting the

female worm with considerable accuracy, but probably owing to the pain caused by this procedure in the absence of local anæsthesia, the method never received the attention it deserved. For a long period no improvement in operative technique eventuated. The utilisation of local anæsthesia however and Hudellet's method of localising the parasite by special X-ray technique are very decided advances on older methods.

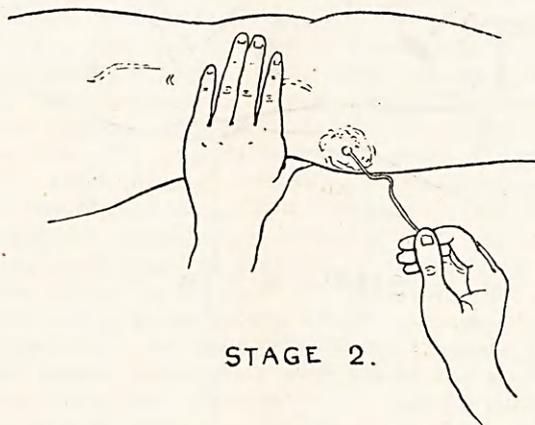
The following operation which I have used successfully on a number of cases is based on a detailed study of the pathology of the disease and is applicable wherever the outline of the worm can be defined, either prior to or after spraying the tissues with ethyl chloride or by Hudellet's X-ray technique. Its application is independent of whether a blister has or has not formed or whether a sinus is present. If the worm is presenting (Stage 1)

Line drawings illustrating the various stages in the operation for the removal of *Dracunculus medinensis* from the subcutaneous tissues.



STAGE 1.

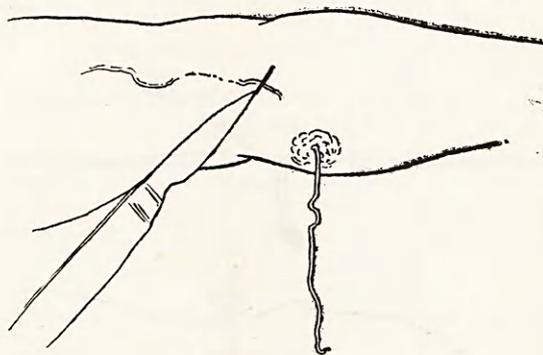
the first step is to attempt extraction by intermittent traction and massage (Stage 2). When, as



STAGE 2.

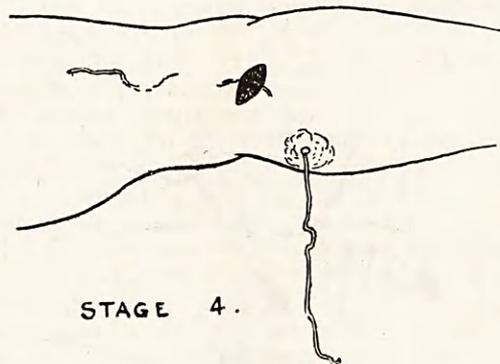
frequently happens, complete extraction is unsuccessful, the skin overlying the worm at

some little distance from the guinea-worm ulcer is infiltrated with cocaine and adrenalin, (the solution used contains 2 c.c. of 1 per cent. cocaine and 1 c.c. of 1/2000 adrenalin), and an incision is made through the anæsthetised tissues at right angles to the line of the worm (Stage 3). By this means the whitish fibrous sheath of the worm is exposed



STAGE 3

(Stage 4). The superior surface of the sheath is incised in a longitudinal direction and a small strabismus hook is inserted inside its glistening white interior. By this means the female *D. medinensis* is hooked out (Stage 5). The loop of

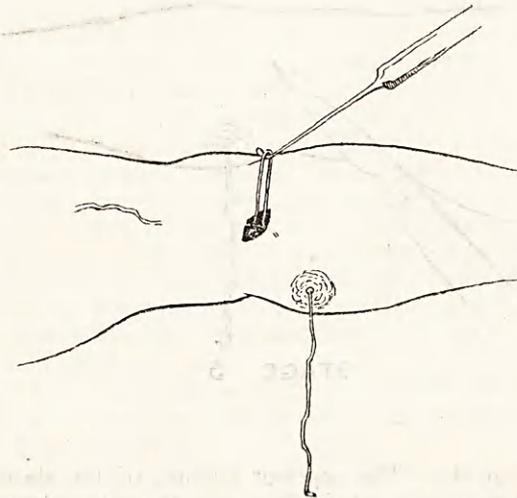


STAGE 4.

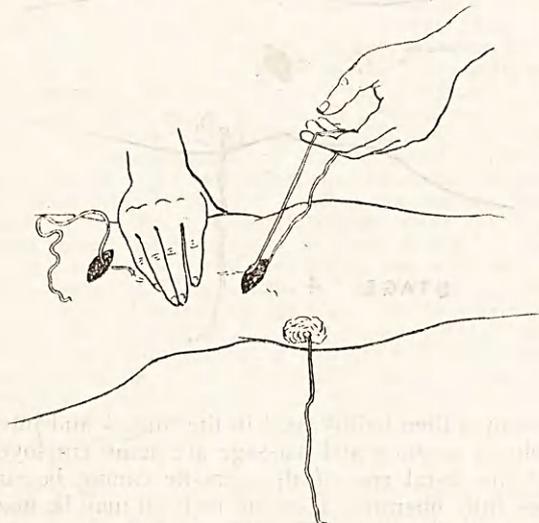
worm is then lightly held in the fingers and intermittent traction and massage are again employed. If the distal end of the parasite cannot be successfully liberated, a second incision may be made over another palpable segment of the worm and by adopting a similar procedure the distal portion is liberated (Stage 6). Both ends of the central loop are now cut across and the intermediary portion removed. The distal and proximal portions of the worm are removed as shown in Stages 7 and 8. It is important that the proximal head portion of the worm should be removed through the sinus in the direction

indicated in the diagram (Stages 7 and 8) and not drawn through the sheath in the subcutaneous tissues in the reverse direction, as otherwise soiling of this area with organisms from the mouth of

the worm across at any stage of the operation as the few embryos which are spilt in the tissues cause no trouble. Indeed, we have noted that when a portion of the worm



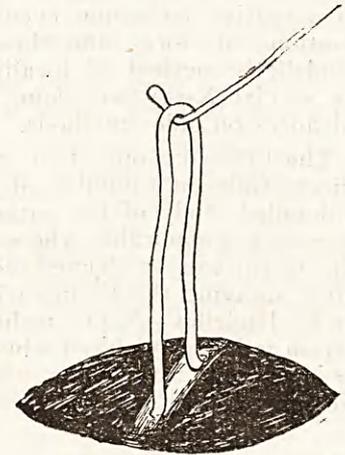
the sinus might ensue. The end of the strabismus hook or a probe may now be inserted into the sinus, which is excised in an oval fashion (Figures 7 and 8). One or two sutures may be



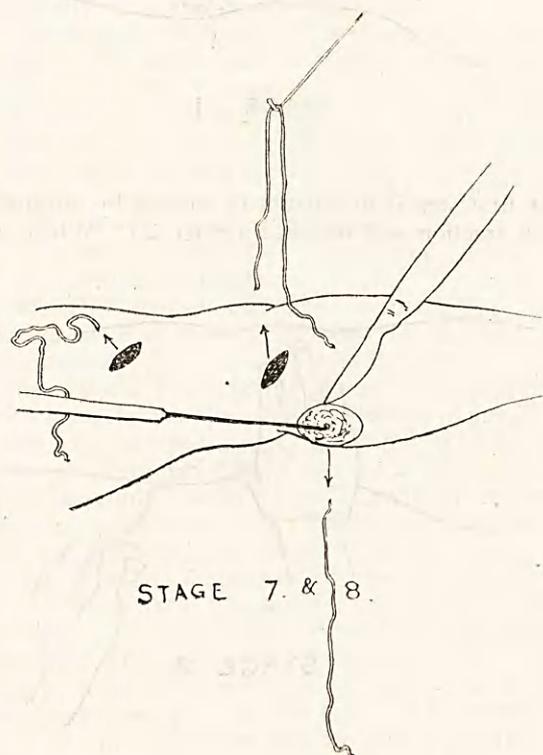
STAGE 6

indicated to bring the edges of the excised area together (Stage 9), but it is not necessary to suture the other incisions which heal rapidly without doing so (Stage 10). Under ordinary circumstances there is no objection to cutting

STAGE 5



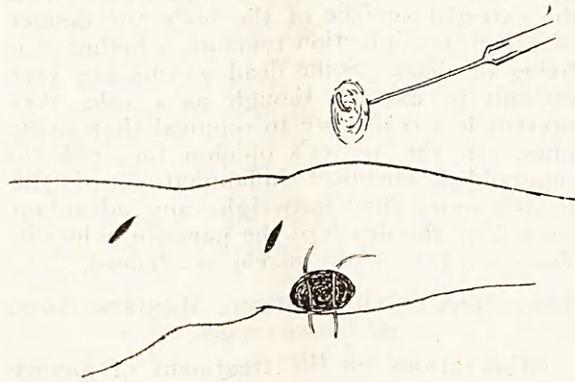
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STAGE 7 & 8

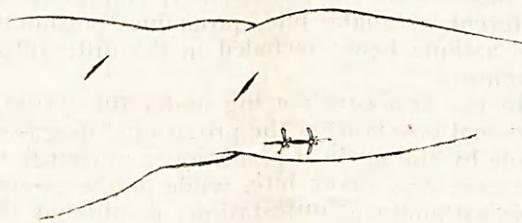
has been left *in situ* at operation the incision sometimes healed rapidly and the residual

portion of the worm was absorbed, provided post-operative secondary infection was avoided. Excision of the proximal end of the



STAGE 9.

sinus as described above is by no means always necessary and in a large ulcer is not advisable. For the more chronic cases with a small sinus opening to the exterior, excision



STAGE 10.

is a simple procedure and has the advantage of obliterating a potentially dangerous area of infected tissue.

The advantages of such an operative procedure are evident. It can be performed rapidly and painlessly and even when, as occasionally happens, the whole worm is impossible to remove at one sitting, the residual portion can be left *in situ*, simply rolling its free end around antiseptic cotton wool and subsequently extracting. The incidence of complications and the duration of the illness are markedly lessened. The actual results obtained in a series of nineteen cases are shown in Protocol No. 2. Note that in the twelve cases where the worm was completely removed no complications ensued. Of the seven cases where removal of the worm was incomplete, absorption *in situ* occurred in several instances and four of the seven patients were well within fourteen days. In one case exuberant granulation tissue developed and hampered convalescence, while in three a variable grade of secondary infection occurred. Had facilities been available for

daily dressing and rest as in-patients for three or four days after the operation, instead of irregular treatment in an out-patient clinic, such complications might well have been avoided. In only one case was the sepsis severe. Here an acute abscess developed in the track of a broken worm on the twelfth day after operation necessitating the patient resting in bed for several days during the second and third week. Cure was established at the end of the fourth week.

PROTOCOL No. 2.

Results of operative Treatment in 19 cases of Dracontiasis.

Removal of worm.	Number of cases.	PERIOD OF AFTER-TREATMENT.				Complications.
		Under 7 days.	Under 14 days.	Under 21 days.	Under 28 days.	
Complete ..	12	11	1	0	0	Nil.
Incomplete..	7	2	1	0	0	Nil.
		0	1	1	1*	Sepsis. Exuberant granulation tissue.
* TOTAL ..	19	13	3	2	1	

* This case progressed satisfactorily until the 12th day after operation and then suddenly developed an abscess.

When the average duration of dracontiasis is considered, under the ordinary treatment of winding and douching, the satisfactory nature of these operative results in reducing the period of sickness becomes apparent. In India both Acton (1910) and Liston (1914) independently estimated the duration of illness when treated by winding and douching as one month or over, while in Africa Cummins (1911) states it to be thirty days and Graham (1905) twenty-two and four-five days (22.8). Both the later workers treated their cases as in-patients and Graham admits his estimate to be low as his patients were only fit for light duty when discharged. In this series, out of nineteen cases thirteen were completely cured in seven days, three within fourteen days, two within twenty-one days and the remaining one within one month of operation.

THE LOCAL INJECTION OF ANTISEPTIC AND NARCOTIC DRUGS.

Different observers have advocated the local injection of antiseptics into the worm and the surrounding tissues with the object of destroying the parasite *in situ*. Emily (1894) first introduced the perchloride of mercury treatment. He injected twenty to

forty minims of a 1 in 1000 solution of perchloride of mercury by means of a Pravaz's syringe either into the body of the protruding worm or into the subcutaneous tissues around its palpable coils. Davoren (1894) and Lamb (1898) confirmed Emily's results. Four years later Foulkes (1898) claimed that the injection of alcohol was a method of great utility. Acton (1910) criticised Emily's treatment on the basis that following injection of perchloride of mercury, an insoluble mercury albuminate was immediately formed, while Cummins (1911) expressed doubt as to its real value from the clinical view point. Vorwerk (1912) and Montais, Jamot and Robert (1914) have all discarded the method after trial. The latter observers conclude that injections of cocaine, chloroform, ether, anthelmintic substances or perchloride of mercury into or surrounding the worm are all unsatisfactory. Graham Forbes (1920) recently stated that the injection of perchloride of mercury (1 in 1000) was not successful under campaign conditions, where the only safe and reliable method was to follow the long established custom of slow extraction by cold water douching.

Acton (1910) advocated the local injection of chinisol (a potassium salt of a compound oxylichinole and sulphuric acid), the tissues surrounding the parasite being infiltrated with one drachm of a 1 per cent. solution. A careful antiseptic toilet of the skin was advocated and a strong case was made out for this mode of therapy. The results in a series of 19 cases were extremely satisfactory. Liston and Turkhud (1923) treated a series of cases by local injection with chinisol at Sarsola village. The female worms were killed but the local reactions which resulted were so severe that the method had to be abandoned. In Acton's series local reactions were not excessive. Chitale (1912) suggested the injection of alcohol and chromic acid to harden the parasite and lessen the risk of breakage during extraction, while Gupta (1917) claimed marvellous results from the deep injection of tincture of iodine at the seat of the worm. Bécère (1903) advised the application of chloroform to the free end of the worm which is extracted by the rolling method. Cocainisation of the parasite, as advocated by Lefebvre (1908), has in my experience proved of no special value in facilitating extraction. The writer has seen the most extensive sloughing of the tissues result from the local injection of metallic mercury in the vicinity of a guinea-worm. Such treatment is crude and is to be entirely deprecated.

In reviewing the methods of local injection it is observed that though many different antiseptic and narcotic drugs have been advocated from time to time, no one method has attained any conspicuous or universal success. It

must be remembered that *D. medinensis*, even though killed by chemical, means generally needs to be mechanically extracted, and once the worm has established communication with the external surface of the body the danger of secondary infection remains, whether it is living or dead. Some dead worms are very difficult to extract, though as a rule they present less resistance to removal than living ones. In the writer's opinion the risk of superadded chemical inflammation of the tissues more than outweighs any advantage caused by the death of the parasite unless its absorption *in situ* can thereby be attained.

TREATMENT OF THE SYSTEMIC MANIFESTATIONS OF DRACONTIASIS.

Observations on the treatment of guinea-worm disease would be incomplete without reference to the remarkable therapeutic action of adrenalin in relieving the distressing prodromata such as urticaria, dyspnoea and the like which so frequently herald the appearance of *D. medinensis* on the external surface of the body.

During these early manifestations, the recognition of the causal agent may not always be obvious to the practitioner, conditions as different as snake bite, ptomaine poisoning, and asthma being included in the differential diagnosis.

In the first case coming under the writer's personal observation the provisional diagnosis made by the medical practitioner in charge of the case was snake bite, while in the second case asthmatic manifestations dominated the clinical picture. The presence of local itching and œdema in the extremities, specially if associated with the appearance of a small vesicle in the dermis will enable a definite diagnosis to be made.

The writer has found that the administration of 10 m. of 1 in 1000 solution of adrenalin hydrochloride by the subcutaneous route is a most efficient drug in this stage of the disease. Adrenalin affords immediate relief, analogous to that which it exerts in spasmodic asthma. The urticaria, erythema, dyspnoea, asthmatic manifestations and other symptoms rapidly disappear. Relapse may occur. When this happens a second injection is indicated. Theoretical considerations suggest that atropine should prove equally efficacious.

SUMMARY AND CONCLUSIONS.

1. The treatment of dracontiasis should be based on the particular pathological condition present and varies according to the stage in which the lesion is first observed, and the presence or absence of complications, especially septic infection.

2. In operating on a worm located prior to blister formation it is necessary to remember that rupture of the parasite is very liable

to be followed within a few hours by urticaria, vomiting, etc. After blister formation this complication need not be feared.

3. When a blister is present, it is sound practice to aspirate the blister fluid under sterile precautions so as to limit the size of the subsequent ulcer. Perivesicular œdema is often excessive in this stage, and, if so, it is advisable to temporarily postpone operation until it has subsided.

4. Once the blister has ruptured and an ulcer formed, care must be taken to avoid septic complications as the ulcer base and the central sinus are almost invariably infected with pathogenic organisms. Breakage of the worm under these circumstances is followed by local abscess or cellulitis, or more rarely arthritis—conditions which may demand immediate surgical intervention.

5. When the worm is closely convoluted, occupying a limited area of tissue, excision *en masse* is the correct treatment.

6. A special method of mechanical extraction is advocated and consists of intermittent traction of the worm accompanied by massage in the direction of the sinus, the muscles in the vicinity being relaxed.

7. A new operative technique based on the structural relationships of the worm is described. The parasite is located and outlined by utilisation of the "cold reflex" and the operation is conducted under local anæsthesia.

8. The results in a series of nineteen cases are tabulated, and of these thirteen were cured within one week, three within a fortnight, and two within twenty-one days. The remaining case, which was complicated by a local abscess, took one month to recover.

9. Regarding local injections of antiseptic and narcotic drugs, no one method has met with anything approaching unqualified success in the hands of different investigators. It would appear that the risk of super-added chemical inflammation of the tissues more than outweighs any advantage caused by the death of *D. medinensis*, unless its absorption *in situ* can be thereby attained. This result is only likely when worms are located prior to blister formation. Under these circumstances the risks of secondary infection are remote.

10. The subcutaneous injection of m.x. of 1 in 1000 solution of adrenalin hydrochloride has been found to immediately relieve the distressing prodromal symptoms such as urticaria, erythema and asthmatic manifestations which so often herald the appearance of *D. medinensis* in the subcutaneous tissues. Its use in this stage of the disease is advocated.

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THE DIAGNOSIS OF KALA-AZAR BY EXAMINATION OF THICK BLOOD FILMS.

By R. KNOWLES,

MAJOR, I.M.S.,

and

B. M. DAS GUPTA, L.M.P. (Tempy. Asst. Surgn.),

From the Protozoology Department, Calcutta School of Tropical Medicine.

THE diagnosis of kala-azar can only be properly confirmed by the finding of *Leishmania donovani* in films taken from the blood, spleen juice, liver juice, etc., of the patient. However valuable the serological tests may be, they cannot be said to be absolutely infallibly diagnostic or to be free from possible misinterpretations and fallacies. Even with Napier's aldehyde test, which we regard as the most reliable of all, the serum only commences to give a positive reaction at about the fourth or fifth month of the disease.

To establish the diagnosis of kala-azar by discovery of the specific parasite, we have always held and still hold that the readiest, most reliable and best method is to do spleen puncture and examine films of and N. N. N. cultures from such material. We are accustomed to performing some two or three spleen punctures daily in our laboratory upon out-patients, and have been in the habit of constantly performing this trifling operation now for seven years, without having seen a single accident or harmful symptom resulting.

Yet the ordinary medical practitioner in Bengal rarely carries out spleen or liver puncture, he and his patients alike being under the erroneous impression that these are dangerous procedures. There are still two further ways in which the diagnosis can be clinched by the discovery of the parasite:—

(a) Culture of the peripheral blood by Row's method. As shewn by the junior author (Das Gupta, 1922) and others, such a method yields positive findings in some 98 per cent. of untreated cases. Yet it requires full laboratory facilities, which are not available to the ordinary general practitioner.

(b) Searching the leucocyte edge of some 6 to 12 thin films of the peripheral blood for parasites. To quote a remark made by a candidate at a recent examination, however,

"the method requires the technique of an expert and the patience of Job."

Accordingly, we have from time to time during the past seven years experimented with different thick blood film methods, methods of dehaemoglobinizing blood and of preparing leucocyte films, etc., with previously disappointing results: (e.g., Knowles, 1920, pp. 164-165).

It is curious indeed how diametrically opposite are the views held by different workers as to the value of examination of thick blood films for the presence or absence of the blood-inhabiting protozoa. Thus, as regards malaria, Stitt (1923, p. 300) regards the method as "of the greatest practical assistance in searching for malaria parasites, when in very small numbers in the peripheral circulation." James (1920, p. 172) considers that "the thick-drop method as a whole is crude, and provides opportunities for many diagnostic errors. It should be employed only to supplement the ordinary thin film method, never as a substitute for that method." Until recently our opinion coincided with that of James. Yet some workers appear to have brilliant results with the thick film method and to rely upon it as a routine diagnostic procedure in malaria,—others to consider it of very little value. We are inclined to consider that this difference of opinion may be due largely to differences in the technique employed.

In July 1923, there appeared a paper by Szilard which we read with great interest. In it he described a method of isolating and collecting together living leucocytes in enormous numbers for opsonic and similar work. The technique employed was to haemolyse the blood by a mixture of acetic and tartaric acids, to exactly neutralize the haemolysed blood with a solution of potassium hydrate, to collect the leucocytes by centrifuging, and to wash them in Locke's solution. Two very striking illustrations shew the results obtained, microscope fields crammed with myriads of leucocytes which are viable and which retain their staining properties.

It appeared to us that this method would be of great value in the diagnosis of kala-azar. The full technique of Szilard demands laboratory facilities which are not at the disposal of the general practitioner, whilst the time employed would render the full technique unsuitable for routine use in the diagnosis of kala-azar. After trial of two or three different modifications, however, we evolved a technique, founded upon Szilard's paper, which has given us excellent results.

Technique.—In all thick blood film work, the most meticulous attention must be paid to details; nothing spoils a thick film for examination more than the presence of deposit of stain, dirt or bacteria. The glass slides used for the films must be perfectly clean and polished, and should be freed from grease by flaming.