band in the inner border of the forearm, or may comprise the whole ulnar half of the limb, including the two or three ulnar fingers. Here too, as on the legs, the analgesia is rarely complete, and is often represented only by a relative insensibility as compared with the radial borders of the arms.

Duchenne observed many years ago that the face is occasionally analgesic in tabes, or rather that portion of it which is supplied by the trigeminal nerve. He spoke of this trigeminal loss as "*le masque tabétique*," but a complete mask is rare. Some diminution of sensibility to pin-prick is, however, extremely common on an irregular area in the centre of the face, especially on the nose and the neighbouring portion of the cheeks. It is an important symptom, as sensory loss of this distribution is not found in any other nervous disease, except perhaps leprosy. It is easily demonstrated, for probably on no part of the body is the prick of a sharp pin so painful as on the nose and adjoining portions of the cheeks, and it is exactly here that sensibility is often lost or diminished in tabes. The area affected may vary from a small patch on the nose to the greater part of the face, until indeed it forms a typical tabetic mask. If slight it may be apparent only when the sensibility is contrasted with that of a normal area, as on the neck.

The diminution, loss, or alteration of sensibility to pin-prick in some or all of these areas—that is, the distal portions of the lower limbs, the thoracic zone, the radial borders of the arms, and the central portion of the face—constitutes the most common, the most definite, and the most characteristic physical sign of tabes dorsalis. It is frequently present when the knee-jerks and the pupillary reactions are normal and before ataxia or other symptoms develop, and it is consequently a most important phenomenon in the diagnosis of the disease. The loss of sensation in these areas is a dissociated one—that is, its different modalities are affected in different degrees, or some forms only may be disturbed. Touch, for instance, is frequently intact on the chest and face at least, and the affection of thermal sensibility is inconstant and irregular. Its diagnostic value is enhanced by the fact that in no other disease is there dissociated analgesia of a similar distribution.

Though I lay so much weight on the presence of this cutaneous analgesia as a diagnostic sign owing to its constancy and the simplicity with which it can be demonstrated, I do not wish to underestimate the importance of other sensory disturbances. Tactile sensibility is rarely profoundly affected, but is often reduced, especially on the legs. Thermal sensibility is more irregular, and as the sensations evoked by the contact of hot and cold test objects may be perverted rather than reduced, its investigation is too difficult for ordinary clinical purposes. On the other hand, though changes in so-called deep sensation—that is, the sense of position and movement, the recognition of size, shape, and weight, and the appreciation of vibration—are certainly the most important in the pathogenesis of the symptoms of the disease, their investigation requires more care and skill, and disturbances in them are much less constant in the slighter cases and in the early stages.

Few diseases are so protean and irregular in their manifestations; few, if any, present so many symptoms that may lead us into error in diagnosis and prognosis, and few require in their early stages so much care in investigation and treatment. I have endeavoured to put before you some of the pitfalls that await us, for consciousness of danger is our surest safeguard, and to point out the simplest means by which, in my experience, we may avoid mistakes.

THE question of indirect advertising has been occupying the General Council of the Bar. The annual report for 1922 states that the attention of the Council was called to an article, which appeared with sensational headings in a Sunday newspaper, purporting to be written by a leading counsel. When asked for an explanation, this gentleman stated that the managers of the paper had pressed him to see a reporter and to give him his views on a legal subject. After several refusals the counsel ultimately acceded to the request, warning the reporter that the interview was not to be used in any way that might be regarded as advertising himself. The interviewer apparently worked up the conversation into an article, which appeared under the name of the counsel as if it had been actually written by him. Eventually the managers of the paper expressed regret for what had occurred. The General Council of the Bar, with a view to avoiding possible misunderstanding in the future, has passed the following resolution: "That it is contrary to the etiquette of the Bar for a practising barrister to give an interview to a representative of the press on any matter in which he has been or is engaged as counsel."

SOME APPLICATIONS OF PHYSIOLOGY TO MEDICINE.

I.—SENSORY PHENOMENA ASSOCIATED WITH DEFECTIVE BLOOD SUPPLY TO WORKING MUSCLES.

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ACCURATE knowledge of the effects of defective blood supply to the various tissues and organs is obviously of great importance in view of the innumerable conditions of stress, derangement, and disease in which this factor comes into play, with manifold results in the way of disturbed or impaired functions in the different systems of the body. "Defective supply" naturally covers different conditions—quantitative deficiency in normal constituents, or the presence of abnormal and injurious constituents, or inadequacy as regards the volume, pressure, and rapidity of flow of normal blood. This communication deals with the last-named—certain effects of deficiency in the supply of normal blood to normal muscles.

Many impairments of functional activity from more or less extensive interference with blood supply have long been known, such as the weakening of the heart muscle from deficient coronary supply and the common occurrence of fibrillation after sudden coronary obstruction; the effects on the brain in the form of giddiness, faintness, or loss of consciousness; and the primarily exciting and secondarily depressing influences exercised powerfully on the medulla (respiratory, vasomotor, and cardio-inhibitory centres, etc.) and on the spinal centres from sufficiently extensive or sudden acute lack of blood supply; also the derangement or stoppage of kidney function from similar interference.

Various observations are on record dealing with the functional behaviour of excised organs and muscles artificially perfused with blood or in the exsanguine condition, and also observations on the effects of artificial interference with the blood supply of organs and muscles *in situ* in animal experiments. Under such conditions there is of course no information obtainable as to sensory phenomena attendant on altered blood supply in the conditions of rest and activity.

The present inquiry deals with the behaviour of human muscles temporarily deprived of their blood supply while their normal innervation remains intact; the sensory phenomena recognizable in the states of rest and activity are examined and brought into relation with other functional conditions, such as changes in contractile power, etc.

Methods of Experiment.

The forearm was investigated (*a*) while the normal circulation was going on, and (*b*) when the blood supply was stopped, the limb either retaining its blood in a stationary condition or being rendered exsanguine before the circulation was arrested—that is, the "congested arm" and the "ischaemic" arm were examined with arrested circulation. The circulation was stopped by a blood pressure armlet applied to the upper arm, which was rapidly pumped up to a constricting pressure much above what was necessary to produce arterial obliteration in the particular individual examined—that is, an armlet pressure largely exceeding the systolic pressure. When this was done in the usual way, as for the measurement of systolic blood pressure, a "congested arm" was obtained containing a large amount of stationary blood shut off from the general circulation, the veins becoming prominent and tense. To obtain the bloodless or ischaemic arm an elastic bandage was first applied to the hand and arm, and removed after the armlet had been pumped up as described.

In the congested arm the sensory phenomena are naturally complex, being partly attributable to conditions attendant on the arrest of the circulation as influencing the muscles, etc., and partly to the discomfort caused by the venous turgescence. To avoid the latter complication the method of the ischaemic arm is employed; the sensations induced by muscular activity in presence of acute want of blood can then be examined.

Under these conditions muscular action was tested in various ways. Graphic records of the flexor muscle of the

middle finger were made by means of a Mosso's ergograph, the voluntary flexion movements being made in regular series—one in one second or in two seconds, etc.—timed by a metronome, while the weight lifted at each contraction varied in different experiments from 1 to 3 kg. The behaviour of the muscle in different conditions, the amounts of mechanical work done as measured in kilogram-metres, the development of fatigue, etc., were graphically recorded, while the sensations associated with different phases were noted. The results as regards fatigue, etc., will be described elsewhere, the present communication having to do with the sensory phenomena.

Another method is to use a series of grasping movements with the hand, bringing them to bear on a dynamometer or a dynamograph; this method is in some respects less precise than the preceding.

Another mode of experiment was to use the abductor indicis muscle, working against the resistance of a strong elastic band embracing the fingers; successive abduction movements of the fingers were then made in regular series; only the hand was rendered ischaemic in this case, the armlet being applied to the forearm. The hand was supported on a table with the palmar surface downwards. Graphic records can be obtained by making the movements of the finger inscribe on a moving smoked paper.

Ischaemia of the Resting Arm.

In observations made by these methods it was found that simple deprivation of blood in the ischaemic limb for periods up to twenty minutes caused no great sensory effects, only coldness in the bloodless part, with an inclination to shift the position of the limb, and a certain amount of discomfort from the continued constriction by the obliterating armlet; the absence of pain is to be noted.

Muscular Action in the Ischaemic Arm.

Muscular action in the ischaemic limb soon becomes painful, and when carried to the point of "fatigue" is acutely painful. "Fatigue" is indicated by inability to go on executing contraction movements even of greatly reduced range. This index of "fatigue" is convenient for comparing the state of matters in normal and ischaemic muscles, though it does not represent inability of the muscle to do more mechanical work in more favourable circumstances—for example, with less resistance opposing the contraction, a lighter weight to lift, etc. It is a useful index of the stage of enfeeblement of the voluntary contractile power with which the sensory manifestations in muscles under different conditions can be correlated. The actual time necessary to induce fatigue and the number of movements that can be executed prior to this point are of course largely influenced by the weight used; with a sufficiently light weight the movements can be kept up for hours without the occurrence of fatigue in the normal arm while the circulation is intact. Under normal conditions the phenomena of fatigue as shown by ergograph records are well known. The associated sensations as the fatigue point is approached take the form of a sense of increased effort being necessary to raise the weight even for a short distance, an increasing disinclination to go on making the successive efforts, aching or dull pain in the central part of the forearm, etc. We have often found a certain amount of local tenderness to pressure in the fatigued muscles, lasting for some little time after action has been discontinued.

In the ischaemic arm the fatigue point is reached much more rapidly, often in one-half or one-third the time needed in the normal arm, with a proportionate diminution in the number of contractions executed, the more rapid development of extensive weakening at a relatively early stage, etc. Pain develops and by the time the fatigue point is reached becomes severe; further efforts at contraction movements lead to distressingly acute pain and the desire for relief becomes urgent, while there is a strong disinclination to attempt further efforts.

Distribution and Characters of the Pain.

The pain is felt over the flexor aspect of the forearm and is most intense in the central part of the forearm; it is specially marked from wrist to elbow along the line of the flexor digitorum sublimis. It seems to be centred in the belly of the working muscle with a good deal of spreading, but there is, as a rule, no referred pain in more distant parts; in one subject pain in the palm of the hand was complained of. The pain goes on increasing progressively while contractile activity is kept up; there is no remission, as may sometimes occur markedly in the normal arm, where, working with a suitable load, decided aching may develop at a comparative early stage, to pass off more or less completely at a later stage.

It is to be noted that the pain, increasing to almost intolerable severity in some of these experiments, arises from exercise of a comparatively small amount of muscular tissue —the limited portion of the flexor muscle engaged in moving a single finger—in presence of an acute lack of blood supply, involving urgent want of oxygen (anoxaemia) and its consequences, with excessive accumulation of metabolic products, acids, and other bodies. The pain is no doubt protective in character, tending to limitation of effort and shielding the muscle from being spurred on to further and injurious activity. Discontinuance of further effort for short periods does not remove the pain, but it is almost immediately relieved—in a few seconds—by readmission of blood into the limb by removal of the obliterating pressure of the armlet. Contractile energy, on the other hand, recovers gradually and slowly; it takes some time to be fully re-established, and even then is apt to fail more readily than before on repetition of the experiment. It is evident that the pain and the depression of contraction force do not run parallel in the ischaemic arm.

Relation of Pain to Weakening of Contraction Force.

The conclusion just stated is supported by the fact that in the ischaemic arm the development of pain in the course of a successive series of contractions is much greater in proportion to the weakening of contraction force than in the arm with intact circulation; with an equally extensive cutting down of the energy of movement in the two types of arm, as shown by the ergograph tracings, there was sharp pain in the ischaemic arm at a stage when there was only a tired feeling with some aching in the normal arm; pain and weakening of contractile force were differently related to one another in the two cases.

It may be noted that in the normal arm slight aching or local tenderness may last for some little time after the exercise of the flexor muscle (as recorded by the ergograph) has been discontinued, while in the ischaemic arm the sharp pain disappears quickly on re-establishment of the circulation. There is reason to believe that in fatigue following severe muscular exertion under normal conditions (for example, football, etc.) the muscular aching and tenderness, felt for a considerable length of time afterwards, especially in individuals out of training, are dependent on a mechanism of production that is not identical with that of the pain caused by working an ischaemic muscle.

The production of severe pain from a small amount of skeletal muscle working with its blood supply cut off recalls the agonizing pain excited by excessive contraction of a small amount of unstriped muscle in a bit of bile duct in gall-stone colic, or of ureter in renal colic, etc. Of course it does not follow that the mechanism of pain production is similar in the two kinds of muscle—the unstriated and the striated.

Observations on the Abductor Indicis Muscle.

Experiments with the abductor indicis muscle gave results essentially similar to those described above. For example, in an experiment when a certain strength of elastic band was used to resist the abduction movement, a series of about 240 movements could be carried out in the normal state at the rate of one per second before the "fatigue" point was reached—that is, the point where any abduction movement failed to occur against the resistance of the band; this was attended by only slight discomfort and aching—where the latter was present at all. In the ischaemic hand the fatigue point was reached at about one hundred contractions—that is, in less than two minutes, as compared with four minutes in the normal state; this was attended by pain, which spread more or less over the dorsum of the hand, though most sharply felt in the working muscle. Stoppage of the efforts at abduction for a minute did not lead to removal of the pain, but the latter was promptly relieved by re-establishment of the circulation; contractile power recovered much more slowly, and was more easily fatigued subsequently. Some minutes later

the hand was again rendered ischaemic, and kept in that condition with quiescent muscles for ten minutes; the hand became cold, but there was no pain, simple ischaemia having, as described above, no appreciable effect in this respect. Abduction movements of the index finger were then performed as before; there was painful fatigue after about sixty-five movements; the pain was removed as before by readmission of the blood. The usual well-known flushing occurred after the period of ischaemia; sensations of tingling gradually developed somewhat later.

Effects of Continuous Muscular Tension.

Experiments were also performed with the middle finger flexor muscle kept voluntarily contracted to sustain the ergograph weight at a certain level instead of making a series of consecutive lifting efforts as already described; graphic records of the behaviour of the muscle were made. Continuous motor effect failed to preserve the initial level beyond a certain time, which varied according to the weight employed, etc.; then came a general progressive decline, varied by minor irregularities in the slope of the tracing, until after a time the weight sank back to the resting position. This "fatigue" is attended by comparatively little subjective disturbance, even in the ischaemic arm. There was disinclination to keep up the tension of the muscle, which seems to need more and more voluntary effort, with some discomfort and aching—the latter felt chiefly in the upper arm and the finger—probably attributable not to the muscle itself but to the mechanical conditions connected with the fixed position of the limb and pressure on the skin of the finger by the loop at the end of the cord which supports the weight. There is evidently a notable difference as regards pain production between an alternately contracting and relaxing muscle doing mechanical work and the condition of sustained tension necessary to maintain the weight at certain levels. Similar results were obtained with the abductor indicis.

Relation to Pains of Angina Pectoris, Intermittent Claudication, etc.

It need hardly be pointed out that the foregoing observations have a close bearing on the problems associated with the production of the pain of angina pectoris, showing as they do how readily acute pain can be excited in skeletal muscle working with lack of blood supply, the pain developing while the contractile power, though to some extent weakened, is still sufficient to execute movements of considerable range and energy—that is, long before complete fatigue.

There is every reason to believe that processes of the same nature, with a similar production of pain of varying grades of severity, up to the agonizing suffering of fully developed angina, occur in cardiac muscle compelled to work with a blood supply that is inadequate—absolutely or relatively to the amount of work which the arm has to perform. Sir James Mackenzie has emphasized the conception of anginal pain as an expression of exhaustion of the cardiac muscle, commonly associated with a defective coronary blood supply and a susceptible nervous system. He has laid stress on the production of the symptoms of heart failure—pain, breathlessness, giddiness, faintness—as expressions of impaired functions of organs which fail to receive a blood supply adequate to the needs of their normal activities in consequence of a defective output of blood from the heart, the latter itself suffering from insufficient blood supply to its muscular walls; heart failure is thus recognized, not by direct examination of the organ itself, but by the functional effects of diminished blood supply to various organs.

It may be added that the results of the present experiments have an obvious application to the phenomena of the condition called "intermittent claudication," as seen in the legs of men and horses, in which muscular exertion is interrupted by attacks of pain, loss of power, coldness of the limbs, etc. These symptoms can be definitely explained: in consequence of blocking of the main artery, or disease or spasm of the vascular walls, the blood stream has been reduced to such an extent that, while it may suffice to supply the muscles in the resting state, it is quite inadequate for their greater requirements during activity—the results (pain, etc.) of the defective blood supply are of the same nature and mechanism of production as those demonstrable in the ischaemic arm of the healthy subject.

THE CLINICAL, PATHOLOGICAL, AND RADIOLOGICAL ASPECTS OF INFECTION OF THE TEETH AND GUMS.*

BY

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Historical.

SEPTIC absorption from the teeth and gums must date from the earliest period of man's history, for the examination of ancient skulls shows that dental sepsis has ever been present. The clinical symptoms resulting from infection of the teeth and gums must have afflicted the human race during its whole existence, and it is very remarkable that the causation of these symptoms escaped recognition for so long a period. The recognition of the clinical symptoms resulting from oral sepsis is quite modern.

Disease of the teeth and gums was described by H. A. Fauchard in 1740, and from that date much has been written on the subject. In 1875 John T. Riggs gave a full description of the disease in an address read before the American Academy of Dental Surgery on "Suppurative inflammation of the gums and absorption of the gums and alveolar process," and the disease "pyorrhoea alveolaris" is often called "Riggs's disease."

The next advance in knowledge resulted from the development of bacteriology and its application to the investigating of the varieties of organisms causing dental sepsis. Galippe and Professor Miller did valuable pioneer work in this respect from 1884 to 1894. The work of Pasteur and Lord Lister on the great influence of bacterial infection in the causation of disease prepared the way for the recognition of the far-reaching effects of the toxic absorption resulting from the organisms found to be associated with dental infections.

Dr. William Hunter, a distinguished Fellow of this Society, was the pioneer amongst physicians in recognizing "the relation of dental diseases to general diseases," and he read an important paper bearing this title before the Odontological Society of Great Britain in 1900. It is not too much to say that the appreciation to-day of dental sepsis as one of the commonest and most important causes of general diseases is very largely due to the unceasing and untiring work of Hunter in this department of medicine.

The Bacteria Causing Infection of the Teeth and Gums.

Professor Miller of Berlin in 1900 carried out a series of brilliant researches on the bacteria found in connexion with dental infections. He found no less than twenty different bacteria in twelve cases of pyorrhoea; amongst them were streptococci, staphylococci, bacilli of various kinds, and leptothrix. Recently,[1] J. McIntosh, Warwick James, and P. Lazarus-Barlow have isolated a bacillus which they believe to be the cause of dental caries and have named *Bacillus acidophilus odontolyticus.*

In this discussion we are mainly concerned with the organisms occurring in dental infections, the absorption of which, or their toxins, gives rise to general disease. There seems to be no doubt that it is the streptococcus infections which are almost entirely responsible. The streptococci found in mouth infections are usually classified into three groups, from their behaviour when grown on media containing blood.

1. *The Haemolytic group* cause severe toxaemia, and are found in the anaemias resulting from dental sepsis.

2. *The Viridans group* includes those streptococci which are associated with rheumatic affections. *Streptococcus salivarius* and *S. faecalis* belong to this group. They are both toxic, producing general toxaemic symptoms, and may give rise to arthritis, fibrositis, and other rheumatic affections. Arthritis and cardiac lesions have followed the inoculation of rabbits with the living organism in either case. Each of them has been found in malignant endocarditis.

3. *The indifferent group of Streptococci* are not toxic to guinea-pigs, and their association with rheumatic conditions is doubtful.

4. *Gram-negative cocci* are found associated with dental infections, but they are not usually toxic, and some of these types have probably been described as staphylococci in earlier writings.

* Paper read to open the discussion held at the Medical Society of London, December 11th, 1922.