and therefore oxidation, are increased, the temperature of the body heightened, and circulation and respiration accelerated. I cannot forbear quoting the terse sentences of Dr. Michael Foster, as he sums up the nutritive conditions obtaining in the infant organism. He says (*Text-Book of Physiology*, 3rd ed., p. 633): "Metabolism is directed to constructive ends. The food taken represents, undoubtedly, so much potential energy; but, before that energy can assume a vital mode, the food must be converted into tissue; and in such a conversion, morphological and molecular, a large amount of energy must be expended. The metabolic activities of the infant are more pronounced than those of the adult; for the sake, not so much of energies which are spent on the world without, as of energies which are, for a while, buried in the increasing mass of flesh. Thus the infant requires, over and above the wants of the man, not only an income corresponding to the energy of the flesh actually laid on, but also an income corresponding to the energy used up in making that living sculptured flesh out of the dead amorphous proteids, fats, carbohydrates, and salts, which serve as food." Thus, then, in the growing organism, we have not only a greater instability in the nutritive processes, but also a direct source of expenditure in the very fact of growth itself. In consequence of that instability, we find how comparatively slight causative influences may lead to considerable defects in the blood, reducing it below the physiological standard; and, in the fact of growth, we see how the tissues may demand more nutriment than the blood can supply, and an anæmia special to the period of childhood and adolescence may readily be provoked.

At the other extremity of the cycle of life, when the demands are lessened, when all tissues and organs more slowly perform their functions towards the close of the long years of activity through which they have passed; when all the nutritive processes take place with a sluggishness in contrast to the period of active growth; the blood, too, no longer required for the purposes of growth or the renewal of tissues, loses in corpuscular richness and in hæmoglobin, so that one feature of the natural decline of life is the presence of slowly deepening anæmia, which in its turn, probably aids in the diminution of the vital powers. It is plain that a very slight derangement, either in the direction of intake or that of undue waste, must readily influence and intensify this senile anæmia and marasmus.

Turning now to the contrast afforded by the sexes, which up to the age of puberty advance almost in parallel lines, we find, in the first place, that there is a difference in the precise composition of the blood (see Table I), that of the female being notably less rich in corpuscles and hæmoglobin than that of the male; and although, of course, this difference in health is, doubtless, in precise relation to the amount of work called for in each sex, yet, in consequence of it, the female is rendered more liable to become anæmic. She is also subjected to influences special to her sexual function. Ovulation and menstruation go on in health with regularity, and the blood loss they entail is readily renovated. But they are most easily influenced by derangements in health and nutrition; and, on the other hand, when diminished or excessive, may be important factors in the production of anæmia. Pregnancy, the puerperal period, and lactation—severally subject the female to anæmiating conditions, and the cessation of the menstrual function is often the period at which anæmia is developed. Upon the special relations which this function bears to chlorosis I shall have to speak later.

I have no doubt that heredity plays some part in disposing the organism to anæmia, but it is not easy to give instances. A tendency to anæmia may certainly be transmitted, just as a tendency to hæmorrhage, in hæmophilia.

The other conditions, which I have included under predisposing causes, frequently co-operate. Occupation may involve deprivation of a due amount of light and air, the exposure to heightened temperature, and a want of due amount of sleep. I need hardly particularise them further; they are influences which are almost as much exciting as predisposing causes of anæmia; they stand, at any rate, on the borderland between the two groups in the etiology of the condition.

The influence of climate is well known as favouring the anæmic state, the subjection to prolonged tropical heat having a direct influence over and above that which is due to the inertia called forth by life under such conditions.

In conclusion, it must be borne in mind that any given anæmia may arise from a multiplicity of causes, each of which is sufficient of itself to have induced the state; and in the second place the impoverished blood itself reacts on the organism in such a way as to maintain and intensify the anæmic condition. For all the vital processes are influenced by blood defective in the oxygen-carrying substance—hæmoglobin. Hence the capacity of blood for hæmoglobin must be increased, as well as the removal of the primary cause or causes; if any given anæmia is to be remedied. Metabolism must be quickened, and oxygen supplied for that

purpose. I should have hesitated about taking you over—in this hasty survey of the known causes of anæmia—ground so familiar, if this were all that the subject comprised; were that the case, there would have been no need to discuss the subject at all. But when the category of known causes is exhausted, there remain cases of more or less profound and progressive anæmia, to which hitherto no sufficient explanation has been given, leaving the question still open for inquiry and speculation. It is the existence of such a class of "idiopathic" cases that has made me feel it to be necessary that I should speak to day of the factors known to operate in producing the anæmic state, before proceeding to the consideration of that class of disease to which I shall invite your attention in my next lecture.

CLINICAL LECTURE

ON FOREIGN BODIES WITHIN THE EYE,

AND

THE ELECTRO-MAGNET AS AN AID TO THEIR REMOVAL AND DETECTION: WITH CASES.

Delivered at King's College Hospital.

By M. MACDONALD MCHARDY, F.R.C.S.ED.,

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TO-DAY, I wish to call your attention to the most serious class of injuries to which the eye is subject. Foreign bodies, buried in or within the organ of sight, are most fruitful sources of blindness, not only to the eye originally hurt, but to its fellow, through sympathetic mischief. You may take it as an established truism, that every eye, whilst lodging a foreign body, is threatened with destruction by its tenant. Neither the position nor the size of the foreign body negatives this, though both are factors of very material importance in estimating the degree of serious gravity attaching to such a case. Moreover, you must recollect that, as I have just hinted, the danger is not confined to the injured eye, the risk of blindness being shared by its fellow. Sympathetic ophthalmia, an affection indefinitely deferred, insidiously developed, obstinately progressive, and deplorably blinding, often attacks the fellow to an eye rendered useless by a penetrating foreign body, which may be located in any part of the globe.

You may judge, therefore, something of the importance attaching to the detection and removal of such foreign bodies, and the responsibility incurred by one who, undertaking to treat an injured eye, does not do his utmost to arrive at a correct diagnosis regarding the presence or absence therein of a foreign body.

The investigation of these cases should be commenced by the aid of focal illumination; the pencil of light being thrown from every direction on to every visible surface of the globe, so that the position of any superficial indication of a wound may be fully lighted up and searched for by the aid of a magnifying-glass. For this purpose, the two object-glasses commonly supplied in the case with many of the hand-ophthalmoscopes will answer admirably; but if, as I believe is the lot with most of you, your ophthalmoscope be one of those excellent *multum in parvo*, practically efficient, simple, and strictly economical instruments* which I recommended you to procure, then, using the single object-glass thereof for concentrating the light, you will need a second as a magnifier. This may be an ordinary pocket-lens, one of twenty dioptries from the trial-case, a common burning glass, or watchmaker's loupe. I mention this, lest the possession of only a single object-lens with your ophthalmoscope should be conjured into an excuse for the inefficient examination of these cases. The scrutiny, with the two lenses, of the superficial parts, must be extended to the anterior chamber and surface of the iris. Here let me remark on the importance of conducting the examination thus far before applying any mydriatic to dilate the pupil, as it happens at times that foreign bodies which penetrate the cornea, or corneo-scleral junction, remain partially bedded in the tract along which they passed, whilst projecting into the anterior chamber, where the interposition of the iris may serve to screen the capsule of the crystalline lens from injury.

In other instances, a foreign body may be so situated, loose in the anterior chamber of the aqueous humour, that it would be liable to

* Wecker's compounded metrical refraction ophthalmoscope by Crété, Paris, price forty francs; or thirty-five shillings, by Pickard and Curry, London.

fall through a dilated pupil into the posterior chamber, out of sight, behind the iris. Further, the smaller the pupil, the greater the assistance the iris may lend to the safe extraction of a foreign body projecting into, or loose in, the anterior chamber, as you will be able to infer from the two following cases, the narration of which will indicate how similar ones may be brought to a successful issue.

CASE I.—A clerk, aged 33, whilst winding a spring skeleton-clock, the cord of which was frayed, was struck by a fragment, eight millimètres long, of the very fine brass wire composing the frayed cord, which had broken. I immediately examined the injured eye, and could see one extremity and about seven millimètres of the foreign body lying, perfectly straight, in or within the transparent cornea. One end of the wire was concealed beyond the corneal margin; the other was lying beneath the external surface of the cornea, close within the spot at which it was evident the missile had entered. It appeared that a portion of the middle of the fragment was within the aqueous chamber, whilst each end was held embedded in corneal tissue; and this proved to be the case. Having further exposed the visible end of the wire, by a section over it, into, but not through the cornea, I seized the hard body with iris-forceps, which did not grip sufficiently to assist its withdrawal by direct traction; I therefore attempted to turn the freed extremity of the wire forward, anterior to the corneal surface, to admit of its being gripped by dissecting forceps. But this manoeuvre had to be abandoned, as the centre of the wire receded against the iris when the extremity was prised forward. I next made a puncture through the cornea, immediately opposite that portion of the wire which was in the aqueous chamber, about midway between the centre and margin of the cornea, in its upper and inner quadrant; and inserted a Tyrrell's hook through the puncture, beneath and around the wire, so that, when the hook was withdrawn, the portion of wire, bent like a hairpin, came with it. A small portion of iris, which was dragged through the wound between the ends of the wire, was caught in forceps, and removed with scissors, after sufficient had been withdrawn to obviate the risk of any remaining impacted in the corneal wound. Under the use of atropin and a compress, the eye recovered, with no greater impairment of vision than that which resulted from the small excentric corneal scars.

CASE II.—On another occasion, I saw an engineer, aged 22, with a large-sized grain of gunpowder lodged between the cornea and upper part of the iris, the result of an accident on the afternoon of the previous day. There were intense ocular congestion, great photophobia, and discoloration of the aqueous humour. I made a large upward section in the corneo-scleral junction, by transfixion with a Gräfe's knife, taking care not to displace the foreign body by the passage of the blade. A pair of iris-forceps, with points bent at right angles to the shaft, was introduced well into the anterior chamber, as widely open as the section would permit; and then withdrawn closed, so as to have in its grasp the foreign body wrapped around with a large piece of iris, which I cut off with scissors. A simple compress was applied, and nothing occurred to hinder complete recovery.

When the probability of the presence of a foreign body anterior to or in the iris has been excluded, the pupil should be dilated to its widest by the application of a solution of atropine (four grains to an ounce). For these cases, it is better to make the solution with castor-oil, rather than water, as patients with corneal wounds appreciate the lubrication afforded by the thick oil. The search by focal illumination has next to be carried through the wide pupil into the posterior chamber of the aqueous humour. Therein a foreign body may be discovered, resting on the anterior capsule of the crystalline lens, in a position which was completely concealed by the iris, prior to dilatation of the pupil. Though a missile can but very rarely penetrate to such a position without piercing the capsule of the lens, and occasioning opacity thereof by the admission of the aqueous humour, yet it has happened. A wound of the anterior capsule of the lens does not invariably lead to either immediate or complete opacity thereof, though both are its commonest consequences. Cases are on record, and I have met with one such, in which a particular section of an injured lens became opaque, whilst the remainder retained its normal transparency. Still rarer cases are those in which it is reported that foreign bodies buried actually in the substance of a transparent lens have become encapsuled, and surrounded by a but limited opacity; of these I have no personal knowledge. However, you must not be misled by the abundant reports of eyes remaining quiet for long periods whilst tenanted by a foreign body; for such come to crowd the literature of the subject, through being exceptional in the practice of ophthalmic surgeons, who, having to treat vast numbers of eyes with foreign bodies in them, would not report the great many that demand enucleation, whilst too pleased to record the few which furnish the exception needed to prove the rule. Moreover, it is noteworthy that

very many of the reported cases, in which eyes have quietly lodged foreign bodies for several, upwards of twenty, and in one instance twenty-seven years, have attracted attention by the mischief they have finally occasioned. Very frequently, an useless irritable eye is enucleated, and the surgeon receives no clue to the character of the original injury until an examination of the interior of the globe reveals a foreign body.

Individual experience and the statistical investigation of recorded cases alike show that foreign bodies are least tolerated when situated in or upon the ciliary processes, or in contact with the choroid and retina, and are most tolerated in the vitreous or aqueous chamber. They may remain lodged in an old lens, causing complete cataract thereof, and give no further evidence of their location until discovered in the lens after its extraction. The larger a foreign body is, *ceteris paribus*, the more destruction its presence in an eye will work. Dense substances, such as chips of metal, or glass, are usually less mischievous, excepting that they often penetrate more deeply, than splinters of wood or thorns, which may create additional irritation by swelling with the absorption of moisture.

Every blind eye, reasonably suspected to contain a foreign body, should be promptly enucleated, whether it be or be not painful. This is more imperatively necessary with patients of the less educated class, for such will so superstitiously treasure an eye, though it be blind, that, despite every warning from the surgeon, who probably advised enucleation at the time when an accident spoilt the sight, they will seek advice and conceal the truth from a strange doctor when sympathetic mischief arises.

I had an example of this during the present month at the Royal South London Ophthalmic Hospital. Happening to be there on one of Mr. Morton's days of attendance, he called my attention to some symptoms of irritation in the single organ of vision of a young child, whose opposite eye was shrunken, and suggested that they were due to sympathetic ophthalmia. The mother blandly remarked to me, "Oh! sir, you remember the child, you took so much trouble when that eye was blinded two and a half years ago, and I ain't brought the child to you since, 'cos you said directly she suffered anything with either eye, the blind one ought to be took out." In this case, a foreign body had penetrated the sclerotic, and occasioned bleeding into the vitreous chamber, so as to frustrate any immediate search therein. When the extravasated blood became sufficiently absorbed, I could see nothing of the missile, but recognised distinct evidence of it having traversed the whole width of the vitreous chamber, and was therefore led to hope that its momentum had been sufficient to carry it, not only into and across, but also out of the globe; which I was loath to enucleate prematurely in a young child, as the subsequent contraction of the parts would prevent the wearing of an artificial eye, which might be fitted if the globe were enucleated a few years later. Mr. Morton enucleated the globe; it contained a small foreign body surrounded by firm exudation material, and lying at a point behind the ciliary processes, to which it had rebounded from the inner surface of the eye.

Having recommended you to enucleate in such cases, you will be right if you infer that I hold the operation of optico-ciliary neurotomy in no favour; indeed, I believe that, unless speedily abandoned, its introduction as an alternative for enucleation must result in the destruction by sympathetic ophthalmia of many eyes which would never have been exposed to the danger thereof, but for a misplaced confidence reposed in an operation which can offer no advantages compensatory to a diminution of the almost absolute safety securable by timely enucleation.

The following case, which is recorded in the ninth volume of the Clinical Society's *Transactions*, will serve to direct your attention to very many of the points associated with the subject under consideration, and records the occasion which led me to first apply electro-magnets in the treatment of eyes containing iron or steel bodies. It is, moreover, illustrative of the commonest cause of such injuries, and the happy issue which may attend your best efforts to avert their dire consequences.

CASE III.—David B., aged 31, employed in a wood-working-machine shop, came under my care, at the Royal South London Ophthalmic Hospital, in consequence of an injury to his left eye, caused by a chip flying either from a steel tool or from the hammer with which he was striking the tool.

I saw him first on July 4th, 1877, twenty-four hours after the accident, when commencing iritis was indicated by slight ciliary congestion and moderate discoloration of the iris. An altered reflex from a portion of the cornea, below and external to the centre, indicated where the steel chip had impinged. Before dilatation of the pupil, no lenticular opacity could be detected, and the ophthalmoscope revealed nothing abnormal in the vitreous body. The tension was normal; there

was but insignificant tenderness. He stated that the eye was far easier than it had been on the previous night, and that he did not wish to remain in the hospital. Accordingly, as the patient had presented himself at the hospital just before my departure, I prescribed some atropin drops, two grains to the ounce, and directed him to keep his eyes shaded until the next day, when he was to be seen by me again.

On July 5th, the patient said that he had no pain in the eye. The congestion had diminished since the previous day. The pupil was widely dilated; vision equalled twenty-fortieths; the corneal surface was almost normal; but there was a shining, sharply defined opacity, evidently a fragment of metal, upon the anterior surface of the lens, occupying a situation downwards and inwards from its centre. The lens was perfectly transparent, except at the small area hidden by the chip, which was a narrow flat strip, about one-fourth as wide as it was long, and in length about equal to one-fifth the corneal diameter. The foreign body, lying in the direction of the downward and inward meridian of the cornea, had its peripheral end nearer to the margin of the dilated pupil than its other extremity was to the centre, and thus occupied a position which explained how it had been concealed prior to the use of atropine. Reluctant to deal at all precipitately with such a case, I enjoined absolute rest for the patient, took him into the hospital, and continued the use of atropin. From the situation and shape of the chip, if left alone, it was almost certain sooner or later to gravitate down behind the iris, and lead to destructive mischief in one or both eyes; hence its removal was imperative. I recognised the possibility of the lens-capsule being wounded, notwithstanding the continued transparency of the lens; for possibly the chip, by its very presence, was plugging a laceration in the lens-capsule, and thus excluding the aqueous humour. But I could not feel sure that the lens-capsule was so damaged as to necessitate the formation of cataract. I was loath to subject the eye to the dangers which attend the extraction of a transparent lens by the scoop, and could not feel that such a measure would insure the removal of the foreign body.

As the effect of mydriatics diminishes as the aqueous humour escapes, it would have been very difficult, if indeed possible, to keep the foreign body in view during an attempt to dislodge and secure it with forceps; and if, subsequently to effecting its removal thereby, the lens had become opaque, it would have been impossible to decide whether the original injury, or my manipulations, had induced the cataract.

Confronted with these difficulties, it occurred to me that a magnetic spatula would meet the requirements of the case, for thereto I could attach the chip, and watch its movement, if only a needle were matched to the spatula, so that the latter would plug the puncture made by the former, and thus prevent a loss of aqueous humour, and diminution of the pupil. These conditions would have been equally well fulfilled either by a permanent or an electro-magnet; but with the former I foresaw this danger, that the chip, in jumping towards an approaching magnet, might, by some sharp edge, lacerate the capsule. On this ground, an electro-magnet seemed preferable, as it could be applied to the chip before any attractive power was called into play; and this power could be interrupted at pleasure, during the manipulations, so that any undesirable position of the fragment, with reference to the spatula, might be altered before extraction was commenced. Messrs. Weiss made the electro-magnetic spatula, which I exhibit, and which, when connected with a six-celled Smee's battery, seemed likely to fulfil the indications of the case.

The instrument will be seen to consist of a straight piece of soft iron-wire, four millimetres in diameter, having one of its ends, for a distance of fifteen millimetres, dressed down to form a spatula of perfectly uniform stoutness, with a smooth, blunt, flat point, and having coiled upon it six layers of very fine insulated copper-wire, so that the coil extends over about three centimetres of the iron-wire from the spot where it is reduced to the spatula-gauge. This instrument, when connected with the above-named battery, lifted, by its spatula-point, a three-quarter-inch iron tack.

I related the particulars I have just mentioned to my colleague, Mr. Brudenell Carter, who then kindly saw the case with me, and suggested that, before introducing the spatula, it would be well to try what traction, if any, a powerful magnet held in front of the cornea might exert upon the chip—a suggestion so practical, that I was startled to think it had not sooner occurred to me.

On July 6th, the patient being seated in a chair, I held before his cornea this powerful electro-bar-magnet (one ten inches long and an inch in diameter, coiled with four layers of stout insulated wire, and connected with two pint Grove's cells), and gradually approximated one of its poles to the eye, until, when they were about four inches apart, the chip sprang from the lens to the inner surface of the cornea. Thereupon the magnet was withdrawn, and the chip fell into the anterior chamber. The patient was placed upon a couch, ether was adminis-

tered, and an incision was made, through which the chip was evacuated; and a small piece of iris, which prolapsed, was excised. Immediately the chip left the surface of the lens, it revealed a patch of opacity precisely of its own magnitude; and it was, therefore, evident that complete cataract might be anticipated. This followed, and the injured lens underwent absorption, without any inflammatory reaction being produced. Atropin was applied until the absorption was completed; and the patient has normal distant vision with a lens of twelve diopters, and reads No. 1 of Jaeger's types with a lens of fifteen diopters.

This case aroused my desire to ascertain the fullest extent to which electro-magnets could be usefully employed under analogous circumstances, at a time when nothing but patient experimenting offered any hope of deciding what form or strength of electro-magnet might be most advantageously applied; and I became convinced that it was an error to suppose, that, by greatly augmenting the attractive power of a strong magnet, its influence on a minute particle of iron is not increased. This hypothesis demanded contradiction, on account of the frequency and confidence with which it was announced—notwithstanding that it would seem to be disproved by the single fact, that, in accordance with a certain ratio, the more powerful a magnet is, so much greater is the distance at which it will attract an iron filing.

Immediately after the occurrence of this last case, my attention was directed to a paper by Dr. McKeown, in the *Dublin Journal of Medical Science* for September 1876, wherein he narrates how he has successfully used permanent magnets for the diagnosis and treatment of cases of steel and iron within the eye.

Seeking enlightenment on the subject of powerful electro-magnets at a large telegraph-cable manufactory, I found that the *employés* there, when struck in the eye by a chip of iron or steel, instead of seeking the aid of a reputedly dexterous mate, were in the habit of widely separating the eyelids, and approximating the injured organ to the pole of a colossal electro-magnet, with the common result that the chip, no matter how small, left the cornea.

The BRITISH MEDICAL JOURNAL for July 17th, 1880, gives the following quotation, bearing date A.D. 1745. "There was one in Salisbury, who had a piece of iron or steel stuck in the iris of his eye. The person was in very great pain, and came to me. I endeavoured to push the iron out with a small spatula, but could not, and then applied a loadstone to it, and immediately it jumped out." Thus, clearly, there is no novelty about the application of magnetic traction to the extraction of iron or steel chips from the eye. The Salisbury case reads as if the piece stuck through the cornea rather than in the iris. This, too, I think the more probable, as it appears impossible for a foreign body to remain sticking fast in the iris alone, if you consider the character and constant action of that muscle.

Whenever a case of injury to the eye presents itself, with a history that suggests the possible presence of a foreign body, no time must be lost in carrying out the examination as I have just now described; and, if necessary, supplementing that by a most rigorous ophthalmoscopic search through every exposable part of the interior of the globe, for such injuries are most liable to be quickly followed by loss of transparency in the media, either through bleeding or inflammatory exudation; and then ocular evidence of the chip is forbidden. Such a condition is too often present when the case first comes under the surgeon's notice; and then, if there be a possibility of the foreign body being either iron or steel, permanent, or better still, electro-magnets, may render more material assistance, both in its diagnosis and its extraction. You will be able to judge of this from the notes of the case to which I briefly referred at the close of my contribution to the ninth volume of the *Transactions of the Clinical Society*, as follows: "I have succeeded, by the aid alone of an electro-magnet held in front of the cornea, first in diagnosing the presence of, and then in extracting, through the track by which it entered, a fragment of steel, measuring 2 by 5 millimetres, which had been imbedded posterior to the iris for forty-eight hours, during which time the wound of entrance and the pupil had alike become closed with lymph."

Here is the chip in question, and the electro-magnet which extracted it is the same which worked so happily in the case (III) just narrated.

CASE IV.—The patient, a blacksmith, aged 53, was seen twenty-four hours after receiving a blow on the eye by a chip, which flew from his work when he was chipping cast-iron with a steel chisel and steel-faced hammer. He said the blow was a heavy one, and half stunned him; that he was confident he must have been struck with a fragment too large to be buried within the globe. His eye was acutely inflamed; just to one side of the corneal centre there was the scar of a recent wound, which was so plugged with soft lymph as to allow the aqueous humour to be retained. There was severe iritis, and the pupil was blocked. Atropine, freely used during twenty-four hours, did not open the pupil. Then, judging that it would be possible, by the aid of an

electro-magnet, to ascertain whether or not the foreign body, which, from the nature of the circumstances of the accident, was necessarily either steel or iron, and therefore especially susceptible of magnetic influence, had lodged itself within the globe which it had punctured, I proceeded as follows. Placing the north pole of the electro-magnet before the patient's damaged eye, I completed the galvanic circuit, when he immediately exclaimed that the pain of his eye was unbearably augmented. This clearly indicated, not only that the chip was buried within the eye, but that it was materially attracted towards the magnet without. With the patient lying on his back, I held the electro-magnet with its positive pole in close apposition, but not in contact with the wounded cornea; the eyelids being separated by a silver speculum. For about four or five minutes from the commencement of this procedure, the patient complained that the pain was constantly increasing. At the end of ten minutes, the iris was seen projecting forwards on a sharp point, directly behind and in contact with the back of the recently closed corneal wound. When the magnetic traction had been further applied for ten minutes (or for fifteen minutes in all), a metallic surface could be seen penetrating the iris, and becoming hidden in the track of the corneal wound. Five minutes later, a projecting point was visible on the surface of the cornea; but, on withdrawing the magnet to apply mechanical traction to the fragment, it was observed to immediately recede below the corneal surface. The administration of ether was then commenced, as I contemplated re-opening the corneal wound, and thus reducing the resistance opposed to the fragment when attracted by the electro-magnet. During the few minutes occupied in the administration of the ether, the application of the magnet was steadily continued; whilst I gave the eye a slight lateral, and up and down, movement beneath the magnet, for the purpose of causing traction upon the chip in alternating directions, and thus loosening it. Simultaneously with the patient coming fully under the anæsthetic influence, this fragment of metal, measuring 2 by 5 millimètres, weighing .0158 gramme, with sharp ends, passed out of the eye through the track by which it had entered, and fastened itself upon the pole of the magnet. From this time forth the ocular congestion gradually subsided; and there has been no further pain in the eye, which retains good perception of light and normal tension. There is a cataract, also numerous synechiæ; but he is too well satisfied with the present condition of his eyes to submit to the operative treatment necessary to restore useful vision in the damaged one.

In using magnetic traction upon similar cases, it is important to keep the same pole of the magnet towards the chip; for that is almost of necessity not truly soft iron; and therefore becomes, by induction, itself a permanent magnet, and is consequently attracted by and attracts with but one of its ends or poles at a time: hence, it was not merely a piece of good fortune which allowed the chip to come out point, rather than broadside, foremost.

It may be better to apply the north, rather than the south, pole of the magnet in the manner just described, as Drs. John Vansant (*Journal of Psychological Medicine*, New York, April 1870, page 264), and William A. Hammond (*New York Medical Journal*, November 1880, page 453) have stated that the north pole of a magnet does not cause pain when in contact with the conjunctiva; whereas the south pole, under similar circumstances, occasions a sharp sensation and involuntary twitch; but two or three of you, who made the attempt thus to distinguish between the poles of my large electro-magnet, failed to detect any difference.

CASE V.—Last Tuesday week, this patient, a bricklayer, aged 30, of steady habits, whose left eye had been hurt by a chip on the previous day whilst he was cutting brickwork with a steel chisel and steel-faced hammer, consulted me. The vision was materially impaired, the corneal surface was disturbed at its centre, the lens was unusually visible; and far back, behind the very centre of the lens, a small opacity existed, which returned a metallic lustre when properly demonstrated by focal illumination. The most searching examination, both before and after dilatation of the pupil, failed to detect any further abnormal appearance. When examined through ophthalmoscopic illumination during vertical and lateral movement of the globe, the relative movement of the intra-ocular opacity, which was unquestionably an iron or steel chip, proved it to be situated in the optic axis, posterior to the lens, through the centre of which it had unquestionably penetrated. The foreign body rested just anterior to the globe's centre of rotation; viz., rather less than 14 millimètres behind the summit of the cornea. During the second twenty-four hours after the receipt of the injury, the lens had become slightly cloudy, though still readily permitting a view of the chip. Then was the time for any attempt, if such were to be made, to extract the foreign body, the exact size of which could only be approximately judged from the obliquity of its single visible surface. I will refer presently to the experiments I

made to demonstrate, by the deflection of a suspended magnetic needle, the proximity of the ferruginous chip, both before and after magnetising it by induction. The patient's sensations with the north pole of the electro-magnet, the same as used in the two previous cases, just not touching the cornea, did not enable him to distinguish when the galvanic circuit was completed. The steady application of the magnet produced no visible effect upon the chip other than a questionable change in the amount of metallic reflex returned from it, which suggested that, if at all changed in position, the chip was lying more obliquely across, but just as far back along the optic axis. I therefore abandoned all hope of extracting the body without the introduction of some instrument into the vitreous chamber; a proceeding not free from risk, but one which I would too willingly undertake with a reasonable prospect of thereby converting a most serious case into a simple one of traumatic cataract. The next question was, with what instrument and in what direction to attempt the extraction of the chip. Having well magnetised the chip by induction, through the proximity of the large electro-magnet, I similarly rendered a sharp lance-pointed cataract-needle a permanent magnet; selecting for this purpose a needle likely to be capable of making, during its withdrawal, a passage sufficiently wide for the chip. Introducing the point of this magnetised cataract-needle excentrically through the upper and outer quadrant of the cornea, over the still visible annulus of iris, I carried it through the wide pupil, across the aqueous chamber, to the anterior surface of the lens, through which it passed in a direct line to the chip. After making a little lateral movement with my needle-point against the chip, I gently withdrew the former, to which the latter clung through the whole length of the track along which the needle had been thrust, after it had entered the anterior chamber. Removing the cataract-needle from the eye, I left the chip, which declined to follow through such a minute corneal puncture, lying upon the iris. Making a peripheral corneal puncture with a non-magnetic bent broad needle, I passed in the round end of a non-magnetic cataract secondary knife, and, withdrawing the same, found that the magnetic chip had followed into the corneal puncture, whence it was washed either by the flow of aqueous humour or attracted by the approach of iris-forceps intended to grasp it. Here is the chip, which weighs twelve ten-thousandths of a gramme.

The lens, which has since grown universally opaque, is becoming flocculent, and has not as yet, either by pressure or irritation, occasioned iritis. If the eye remain quiet another forty-eight hours—by which time the cataract will probably be very flocculent—I intend to then remove it by suction, as recommended by Mr. Pridgin Teale. The most opposite opinions exist regarding the merits of this mode of dealing with soft cataracts, as different operators have achieved most opposite results from it. I do not hesitate to recommend it most confidently, as being fraught with exceedingly little danger, provided a properly constructed instrument, properly cleansed and disinfected, be properly used. Those instruments are best to which the operator's mouth supplies the suction-power, as the working of a mechanically contrived suction-apparatus must necessarily hamper a hand already fully occupied in directing the orifice of the curette. The curette portion of the instrument should unscrew, so as to admit of its being cleansed more thoroughly than is possible when it is cemented directly on to the glass tube.

You may ask, why not leave this bricklayer's cataractous lens to be absorbed, just as happened in the sawyer, Case III, both patients being of the same age? You should remember—1. that the absorption of such a lens would necessarily occupy many weeks, probably months; 2. that so long as any considerable bulk of the traumatic cataract remains, it may swell, press upon and irritate either the iris or ciliary body, occasioning iritis or cyclitis; 3. that, consequently, the organ of vision continues in jeopardy whilst lodging the cataract, and renders the patient unfit to work. Thus there are at least three weighty facts in favour of the most complete and early removal of a wounded lens, consistent with safety to the eye.

The concluding number of the last volume of the *Boston Medical and Surgical Journal* furnishes an interesting report of cases, in which Drs. Joy Jeffries and Williams successfully utilised the traction of an electro-magnet to facilitate the extraction of steel chips, which had penetrated to the aqueous chamber. Dr. Bradford had furnished them with an electro-magnet, weighing but four ounces, which, when driven by a single bichromate of potash cell, sustained five times its own weight at a distance of one inch from the extremity of the core. Dr. E. Gruening, of New York, after experimenting to concentrate the greatest possible magnetic polarity in the least possible dimensions, has finally constructed a permanent magnet of six parallel steel rods, somewhat separated from one another, with their ends fitted into iron caps, one of which caps terminates with a delicate soft iron stem, thirty-two millimètres long by one millimètre thick and three millimètres wide,

which is capable of sustaining a weight of fifteen grammes. The Germans have been using a Janin's magnet, which is a permanent one composed of layers of watch-spring. By the introduction of the pointed pole of such an instrument between the lips of a scleral incision, Fraenkel was enabled to immediately withdraw from the vitreous chamber a concealed fragment of iron, over the suspected position of which he had cut down.

The examples could be easily multiplied; but, hoping I have said enough to induce you, first, to recognise the possible practical utility of magnetic traction in the extraction of chips of iron or steel within the eye, and, secondly, to produce the most handy and powerful electro-magnet, we will pass to the consideration of their use as an aid to diagnosis.

You are all aware that, in the presence of iron or steel, a delicately balanced magnetic needle is deflected; that a portion of iron or steel, whilst magnetised, is far more capable than previously of deflecting such a needle; that all steel, and such iron fragments as are not absolutely soft, are capable of being magnetised by induction, that is to say, by remaining in the magnetic circle evolved from a neighbouring magnet, with which they need not be in absolute or even approximate contact.

To test the practical applicability of these truths to the diagnosis of the special class of injuries under consideration, I conducted an experiment, of necessity omitting many important, but almost impracticable, precautions, with the bricklayer's eye (Case v), whilst it lodged that minute piece of steel in the vitreous chamber. Suspending a delicately balanced magnetised needle with one pole immediately over the chip, I in vain endeavoured to recognise some deflection of the former. After the chip had been magnetised by induction, and thus rendered more capable of deflecting the magnetic needle, the experiment was repeated, with a negative result. Here let me call your attention, as I demonstrated at the time, to the circumstance that, if the pole of the magnetic needle be allowed to touch the cornea or conjunctiva, the moisture thereon may cause a false deflection, which, unless assigned to the proper cause, might lead to the most erroneous deductions. Dr. T. Pooley, of New York, who has conducted some very interesting experiments on this aid to diagnosis (*vide* Knapp's *Archives* for 1880), believes that it may prove of real use. Though I fear that he is oversanguine on this point, I wish you to know that the negative result furnished by my experiment corroborates his deduction, which was that the test would fail to indicate a magnetised steel chip as small and as deeply placed as was that in the eye of the bricklayer (Case v).

For such investigations the needle must be highly sensitive, and its deflection often very slight. The delicacy of the needle necessitates its protection from the influence of draughts, and the adoption of some means to neutralise the earth's magnetism, whilst the insignificance of the deflection must be met by some such device as the observation of the reflected light in the focus of a concave mirror mounted on one pole of the magnetic needle. But, after providing all these requirements, how can the influence of jar be neutralised efficiently and consistently with the conditions of such a clinical investigation? These momentous strictures were made upon the occasion of Dr. Pooley contributing a report of his experiments; but an equally cogent and still more serious comment is, that even if this method demonstrated two intersecting axes in which the chip rested, it would not give the third axis needful to fix the position of the chip. However, the method is worthy of most careful, intelligent, and patient elaboration; and until success crowns the surgeon's efforts to diagnose intra-ocular fragments of iron or steel by the magnetic needle, recollect to make use of the aid of a powerful electro-magnet in the same direction.

You noted the pain experienced by the blacksmith when his injured eye was well within the magnetic range of the pole of the magnet. That pain enabled him to immediately recognise the completion or interruption of the galvanic current which induced the magnetic action, and therefore furnished conclusive evidence, not only of the lodgment of an iron or steel body, but also that the magnet was exercising a sensible traction thereon. I have used this pain-test, with the electro-magnet, on four other eyes in which the presence of iron or steel was suspected; two experienced pain immediately the galvanic circuit was completed, and these, upon being enucleated, verified the correctness of the diagnosis that they contained the foreign body; the other two being unaffected by the magnet were not enucleated, but were dealt with as the nature of the punctured wound demanded. Up to the present, the behaviour of each of these preserved eyes has confirmed the diagnosis that the projectile which wounded did not remain in the eye.

The facility which the electro-magnet affords of testing, by the making and breaking of the galvanic circuit, the real, as distinguished from the imaginary, pain caused by the proximity of its pole, affords a weighty argument for its selection in preference to the more handy

permanent magnet. Moreover, whilst the latter only admits of saturation, the former can be supersaturated. "Quantity", as distinguished from "intensity", is needed in the current for working an electro-magnet; and this must be attended to in selecting the battery. Furthermore, when you experiment to deflect a magnetic needle with a minute influence, do not forget to remove from yourselves, and from everywhere near, all iron and steel bodies.

Having now narrated my personal knowledge of the value of the electro-magnet as an aid to the removal and detection of iron or steel within the eye, let me ask your best attention to its further development in that direction. Lack of time forbids my entering fully upon the wider subject of foreign bodies in general within the eye, they are very commonly fragments of copper percussion gun-cap and other substances insensible to magnetic influence.

One word of warning, in conclusion: when using powerful electro-magnets, do not wear a watch, lest it be stopped through the steel therein becoming magnetised, and baffle the skill of the would-be repairer.*

ABSTRACT OF LECTURES

ON THE

STRUCTURE OF THE SKELETON IN THE SAUROPSIDA.

Delivered at the Royal College of Surgeons of England.

By W. K. PARKER, F.R.S.,

Hunterian Professor of Anatomy in the College.

LECTURE VII.

THE extinct reptiles are divided into the Plesiosauria, Ichthyosauria, Dicynodontia, Ornithoscelida, Pterosauria, and a number of smaller groups. The Plesiosauria are interesting, from the variety of forms they present; in some, the head, which is not more than one-twelfth or one-thirteenth of the length of the body, is mounted on a neck as long in proportion as that of the swan; but, in others, the head is large and massive, and the neck much shorter. The hind limbs are longer than the fore limbs, and the tail is comparatively short. The cervical vertebrae may exceed forty in number, though generally there are fewer. The neuro-central suture persists for a considerable time, if not during the whole life of these animals. Their cervical ribs have a strong resemblance to those of the crocodile. The dorsal vertebrae number between twenty and twenty-five, and there are usually between thirty and forty caudal vertebrae. There appear to be no sternal ribs, but there are well-developed ossifications of the abdominal wall, arranged in transverse rows from before backwards. The snout is long and tapering, and the nasal apertures are not situated at its extremity, but in front of the orbits. The pectoral arch consists of two very large coracoids, the long axes of which are parallel to one another, while their inner edges meet through the greater part of their extent without overlapping. There can be little doubt that the bones of the limbs were, like those of the cetacea, covered over by integument, so as to form a paddle. They are long-extinct animals, confined to the mesozoic rocks, from the Trias to the chalk inclusive.

The Ichthyosauria resemble in appearance the cetacea; they possess large heads and short necks. The body is fish-like, and propelled by four paddles, the anterior pair being larger than the posterior, and situated close behind the head. The skull is remarkable for the great elongation and tapering form of the snout, the large orbits, the great supratemporal fossa, and the closing over of the infratemporal fossa by plates of bone. Some attained gigantic dimensions, and are found abundantly in the lias and other mesozoic rocks.

The Dicynodonts present many points of resemblance to lizards, turtles, and crocodiles. The skull is massive, and like that of the lizard, as are also the limb-bones. The jaws are like those of the turtle, but in most forms there are two tusks in the upper jaw; the vertebrae are crocodilian.

* Since the above was delivered, Dr. Wolfe, of Glasgow, has allowed me to test the electro-magnetic apparatus which has been supplied to him with the profession of its having received Dr. Hirschberg's approval. I have found it to retain some magnetism during a cessation of the galvanic current around it, thus showing that it is in part a permanent magnet, owing to the employment in its construction of iron that is not pure and soft. Whilst anxious not to be hypercritical about the apparatus, another apparent oversight in its construction suggests itself to me; viz., the very fine gauge of the insulated copper-wire, which, it would seem, must be a source of undue resistance to the galvanic current.