

the distance of the foreign body from the plate. In all my measurements I made roughly on this principle I may state that I have never been more than one millimetre out of the actual distance. Quite apart from the above method the distances can be measured directly with even greater accuracy in the following way. Having developed the plate it is replaced in the holder in its original position by the aid of the north pole-indicator. We now place a sighting-tube with crossed wires and mounted on a divided plate behind the negative (the sensitised glass plate), and looking through each of the double images of the foreign body successively we point the sighting-tube first (according to Fig. 5) towards the Crookes's tube A along the line Aa and then towards the Crookes's tube placed in B along the line Bb. So we get two angles, which permit us to find easily the position of the foreign body; in fact the crossing point of Aa and Bb is the exact spot where the foreign body is to be found.

Messrs. Baker (244, High Holborn), to whose kindness I am greatly indebted for the loan of an improvised apparatus, are now constructing under my direction more complete instruments. When these are finished I hope to extend my researches on this interesting subject. I have also to acknowledge my great indebtedness to Mr. C. Lees Curties for his kind assistance and the able and proficient way in which he helped me in producing the skiagrams.

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ON THE ABSORPTION OF THE EXTREME VIOLET AND ULTRA-VIOLET RAYS OF THE SOLAR SPECTRUM BY HÆMOGLOBIN, ITS COMPOUNDS, AND CERTAIN OF ITS DERIVATIVES.¹

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IN the year 1878 the late Professor J. L. Soret of Geneva,² in his first memoir on the absorption of the ultra-violet rays of the spectrum by diverse organic substances, announced the fact that diluted blood, when examined with the aid of a spectroscope provided with a fluorescent eyepiece, presented in the extreme violet, between Fraunhofer's lines G and H, an absorption band which appeared to him to be slightly shifted towards the less refrangible end of the spectrum when the blood solution was saturated with carbonic oxide. Soret³ subsequently confirmed the accuracy of the above facts, employing the photographic method in his experiments. Since the date of the publication of Soret's short notes on this subject d'Arsonval⁴ has independently, and without referring to Soret's observations, described anew the extreme violet absorption band of the blood-colouring matter, but without adding to the facts discovered by the Swiss observer. The complete absence of all reference to Soret's scanty but interesting and suggestive observations in text-books and treatises on physiology and physiological chemistry, the fact, which my observations soon elicited, that the absorption band of Soret is much more distinctive of the blood-colouring matter than the absorption bands in the visible spectrum which have hitherto engrossed the attention of observers, led me to interest myself in an investigation which promises to throw much light on the relations of the blood-colouring matter to other organic proximate principles, and on the transformations which the blood-colouring matter undergoes in the animal economy.

In this paper it is my object merely to communicate some of the more interesting results which I have hitherto obtained, a full discussion of the details of the research,

which are of special interest to physiologists and physiological chemists, being reserved for future publication. My observations have, for the most part, been carried out with the aid of a spectrometer furnished with a quartz prism and quartz lenses, and the observations were made with the help of photography. The substances which will be referred to in the statement of results are the following:—1. Oxy-hæmoglobin. 2. Hæmoglobin. 3. The CO- and NO-compounds of hæmoglobin. 4. The iron-containing products of decomposition of hæmoglobin and of oxy-hæmoglobin—viz., hæmochromogen (reduced hæmatin) and hæmatin. 5. Methæmoglobin. 6. Hæmatoporphyrin. 7. Bilirubin, hydrobilirubin, and urobilin.

The following are some of the principal results of the investigation:—

1. The compounds of hæmoglobin with oxygen, carbonic oxide, and nitric oxide present, even in highly dilute solutions, an absorption band between Fraunhofer's lines G and H. As a result of a large number of measurements I conclude that in the case of oxyhæmoglobin the mean ray absorbed coincides with λ 414.0—that is to say, the centre of absorption is slightly nearer the red end of the spectrum than Soret had stated; this observer placed the centre of absorption at h (λ 410.1). As Soret had indicated in the case of the compound of carbonic oxide with hæmoglobin the absorption band is slightly displaced towards the less refrangible end of the spectrum. The combination of hæmoglobin with nitric oxide presents an absorption band occupying precisely the position of that of the CO-compounds. In the case of these two compounds the mean ray absorbed corresponds to λ 420.5.

2. When the molecule of dissociable oxygen is removed from oxyhæmoglobin, either by the action of reducing agents or by boiling *in vacuo*, the absorption band in the extreme violet is remarkably displaced towards the less refrangible end of the spectrum, the centre of absorption corresponding to λ 426.0. When we reflect that the addition of a molecule of oxygen to the enormous molecule of hæmoglobin cannot affect in an appreciable manner the mass of the molecule we must conclude that the displacement of the absorption band towards the ultra-violet end when hæmoglobin combines with oxygen (all other conditions remaining the same) indicates that this combination leads to a notable acceleration of the intra-molecular movement, which is the cause of the absorption of the extreme violet rays by hæmoglobin.

3. The absorption of the extreme violet depends on the iron-containing moiety of the hæmoglobin molecule, for whereas it is not presented by the albuminous product of the decomposition of the blood-colouring matter it is characteristic of the acid compounds of hæmatin and of hæmochromogen.

4. Solutions of alkaline hæmatin, even when enormously diluted (1:30,000 of water), exert a general absorption of the ultra-violet and extreme violet, but present no trace of definite absorption, either in the extreme violet or the adjacent ultra-violet region. The compounds of hæmatin with acids—e.g., hæmatin hydrochloride—present even in solutions of great dilution (1:25,000—1:50,000) an intense absorption band, which encroaches more and more on the ultra-violet as the strength of the solution increases. In a solution containing one part of crystallised hæmatin hydrochloride in 20,000 parts of glacial acetic acid the band extends between h and M, the most intense absorption being between h and L. The less refrangible border of this band is sharply defined, whilst the more refrangible border is less definite. As the solution is diluted the band becomes narrower through less and less of the ultra-violet being absorbed. In highly dilute solutions the band which is still intense absorbs both H and K. The acid compounds of hæmatin exhibit, therefore, an absorption band, which is exactly on the boundary of the ultra-violet proper, and which extends further and further into the ultra-violet as the concentration of the solution increases.

5. Solutions of hæmochromogen (reduced hæmatin of Stokes) exhibit an intense absorption band between h and G. The band has the same position as the band of CO-hæmoglobin, but is more intense. When one part of hæmochromogen in 25,000 parts of water (the stratum examined being 10 mm. thick) an intense absorption band occupies the region between λ 410.0 and λ 430.0. From the examination of solution of various strengths it results that the mean ray absorbed corresponds to λ 420.0.

¹ A paper read before the Royal Society on Feb. 11th, 1896.

² Recherches sur l'Absorption des Rayons ultra-violetes par diverses Substances. Archives des Sciences Physiques et Naturelles, vol. lxi. (Geneva, 1878), pp. 322-359.

³ Ibid., vol. lxxvi. (1883), pp. 194, 195, and 204.

⁴ Archives de Physiologie Normale et Pathologique, cinquième série, vol. ii. (1890), pp. 340-346.

6. The absorption of the extreme violet and ultra-violet by methæmoglobin indicates that this body is the product of a partial decomposition of the molecule of oxy-hæmoglobin.

7. The band in the extreme violet (and ultra-violet), which is characteristic of hæmoglobin, its compounds, and certain of its iron-containing derivatives, in no respect depends upon the iron in the molecule. This conclusion is based (1) on the fact that none of the compounds of iron, organic or inorganic, possess the property of producing a definite absorption in the extreme violet or the adjacent ultra-violet; and (2) upon the study of hæmatoporphyrin, a body derived from hæmatin by the removal of the iron which this body contains. Acid solutions of hæmatoporphyrin of extreme dilution exhibit an absorption band between h and H . If the solution be slightly more concentrated K is absorbed, and with increasing concentration of the solution the absorption of the ultra-violet extends more and more. Alkaline solutions of hæmatoporphyrin absorb the same spectral region, but the intensity of the absorption is greater.

8. Neither bilirubin, hydrobilirubin, nor urobilin presents any definite absorption band in the region of the spectrum where the absorption band of hæmoglobin and its derivatives occurs.

ON VARIOUS FORMS OF TALIPES AS DEPICTED BY "X" RAYS.¹

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(Continued from p. 236.)

As stated in my last paper, all that class of deformity in which the heel so falls as to lie nearly in severe cases completely in a right line with the leg, or in the worst cases sloping from that line forward, are classed together under the term "calcaneus." The diagnosis is easy, for if in all its forms the leg be looked at from the side, backward projection of the heel is found to be absent; the tendo Achillis no longer forms a broad ridge with a parallel elongated pit on each side; it lies flat, flaccid, and thin close to the tibia—in fact, the back of the leg is in its lower third either a straight outline or in bad cases (see Fig. 3, p. 235) there may be a little semi-annular protrusion at the level of the malleoli, from the lower edge of which the line runs straight down or even slopes forward. But the projection of the heel thus absent in the normal place is transferred to the sole, where it usually is considerable. Of this deformity there are three forms. The nomenclature of the divisions is not very happy, as in reality the generic name includes differing conditions, wherefore clumsy qualifying adjectives have to be employed. Thus modern works speak of talipes calcaneus congenitus, talipes sursum flexus, and talipes sensu strictiori. It is to the first and second of these that I would limit the name "calcaneus," calling the last (Figs. 3 and 4) "pes percavus." The congenital form is undoubtedly due to position *in utero*.² It is in reality, as said in my previous paper, hyper-extension (dorsal flexion) of the ankle-joint without, save exceptionally, distortion of tarsal bones. The amount and duration of treatment depend on two factors—viz., on the period of gestation, when the foot became fixed in the faulty posture, and on the length of interval between birth and the commencement of treatment. The former must be more or less conjectural. Mode of birth, such as breech presentation with lower limbs straight, restriction of mobility in knee and hip, also signs of pressure on, and ill-development of, foot afford grounds for deduction. Unless the intra-uterine causes have begun very early, which is somewhat unusual, but little is required to rectify the malformity, if it be observed and treated at the time of, or a few hours after, birth. In such cases some persistent stretching downward of the foot for about six or eight minutes with a firm but gentle hand, the application to its dorsum while thus plantar-flexed of a cardboard, tin or poroplastic splint will suffice, but the splint must be removed daily or even

oftener, the extremity rubbed, moved, and after washing, &c., be again splinted. Even when quite cured by these means the nurse or mother must for some months to come prevent relapse by frequent plantar flexion of the extremity. I have seen neglected feet that have been employed in walking and have either had nothing done or have suffered inadequate treatment, where section of the anterior tendons was necessary, but my experience leads to great scepticism as to the necessity for such operation during the first six or eight months of life and *a fortiori* during the first few hours during which the deformity should be attacked. Prognosis of the other two forms is not good; it depends in great measure on the course of the originating paralysis. Hence massage, passive and active movements are even more important than in the other forms of talipes. Electricity by continued and interrupted current, one or both, should be used, not only to ascertain what contractility may remain, but also as a remedial measure. At the same time the sharp bend of the tarsus which the weakened muscles are quite unable to overcome is to be rectified as far as possible by manual and instrumental extension, and when it is strongly marked by such operative measures—division of fasciæ and ligaments—as were advised for the same element of the equinus deformity. Such are, however, to be cautiously employed; the foot in these cases is very feeble, and nothing beyond what is absolutely necessary should be severed. Should sufficient power remain in the surals shortening of the tendo Achillis, either by Mr. Willett's or by Mr. Walsham's method, produces often an immediately satisfactory result, but it must, unfortunately, be confessed that in a large proportion of the cases the benefit is not maintained. Indeed, it would seem that permanent success can hardly be assured unless an amount of power exceptional in calcaneus is retained by the surals; in such favourable cases however it is quite possible that the means previously mentioned added to those indicated in the sequel would have produced at the end of a given number of months an equal or even a better result. Nicoladoni, taking the peronei tendons out of their groove, severing them, and removing a certain quantity of the outer margin of the tendo Achillis, attached with fine sutures the two together. To justify such procedure the surals must be quite powerless and the peronei perfectly healthy. I have no personal experience of this ingenious device, not having of late years met with a case fulfilling those two essentials. Of course, the peronei can never fully replace such a strong mechanism as the combined gastrocnemius and soleus, but some power on the os calcis is better than none at all, especially as it may be somewhat supplemented by extraneous means.

That last sentence leads to the subject of instruments, their value when properly devised and their injurious effects when abused. All portable appliances for club-foot should effect their purpose without inflicting on other parts injury, which may be nearly as bad as, or even worse than, the original trouble. Also the state of the muscle or muscles to be assisted must be considered. For instance, some disease may have rendered a muscle or a group of muscles insufficient to support the body weight though still adequate to uphold some portion of it. If an instrument be employed which takes upon itself the whole of the work it throws those muscles out of employ, they can but get weaker;³ or certain muscles may be unable either to place or maintain an extremity in the normal position unless assisted by the surgeon's hand or by properly directed spring power. To force such an extremity into position, to fasten upon it an appliance either stiff or with too violent springs during all its movements and exercises, will probably confer while the instrument is in place a fallacious appearance of improvement; it will more certainly weaken the muscles that are still to some degree valid, and each investigation at a few weeks' interval will reveal more and more inability to rectify the deformity. Now it is the aim of surgery to restore this power and to avoid condemnation to a life-long use of irons.

The skiagrams of equinus and calcaneus published in my last two papers show the remarkable bend in the mid-tarsal joint. Any appliance consisting of an entire and unjointed sole cannot fight against that condition which, after such

¹ The skiagrams are taken by Mr. Sydney Rowland, Shuter Scholar, St. Bartholomew's Hospital.

² See Parker and Shattock, Transactions of the Pathological Society, vol. xxxv., p. 423, Hoffa, Walsham, and others.

³ There are cases of complete or almost complete paralysis or muscular degeneration from long disuse which show month after month no sign of improvement; one learns to recognise these even at the first or second investigation, and to know that some strong, even stiff, mechanism is the only way of enabling the unfortunates to get about; but this is no excuse for using that last resource on less hopeless cases.