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SPINAL MYOSIS AND REFLEX PUPILLARY
IMMOBILITY

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SPINAL MYOSIS AND REFLEX PUPILLARY
IMMOBILITY.*

AMONG the symptoms recently added to the description of tabes dorsalis, through the researches of neuro-pathologists, and recognized as significant for the same, the phenomena designated as "*spinal myosis*," or better, as "*myosis with reflex pupillary immobility*," will here claim more than ordinary attention.

By the above term is understood that condition of the pupils, in which they usually present a very decided contraction—myosis—and at the same time are completely inexcitable to light, while under accommodative impulses and convergence of the visual axes, they react with perfectly normal promptness.

Discovered and described in the year 1869 by Argyll Robertson,¹ this peculiar condition was confirmed and elaborated in isolated cases by Knapp and Leber,² then from somewhat richer material by Wernicke³ and Hempel.⁴ Hempel (Leber) in particular demonstrated its more frequent appearance in tabes dorsalis, but with Vincent⁵ orig-

* Translated by Dr. W. R. Birdsall of New York, from the author's manuscript.

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inated the first productive observation and elaboration of the subject. He investigated it in tabes, in progressive cerebral paralysis, and in several other diseases of the nervous system, in a large number of cases, and arrived at very important and remarkable results.

I have thoroughly discussed this subject myself in an extensive work on the pathology of tabes dorsalis,⁶ from the standpoint of numerous personal observations, and arrived, in the main, at the same results reached by Vincent.

The results, up to the present time, of the observations in question, may be briefly condensed as follows:

The symptom, reflex pupillary immobility, as I have called inexcitability to the stimulus of light with preserved accommodative movements, appears with remarkable frequency in tabes dorsalis, being one of its most constant signs. It is frequent even in the initial stage; in the ataxic stage being in fact constant. It is not always associated with myosis, however, for the pupils may be of normal expansion, or even abnormally dilated. In the latter stages of the affection, myosis is certainly more frequent, in fact, the rule. Even with amblyopics, reflex immobility is frequent, and myosis may be observed, not infrequently, in complete amaurosis. In progressive paralysis of the insane the reflex pupillary immobility is almost as frequent as in tabes, but associated less frequently with myosis; far more often with inequality of the medium-sized pupil. Under all other circumstances the appearance of this phenomenon is very rare; yet it is to be observed in many other spinal and cerebral affections, in syphilis, etc. For the more exact semeiotic valuation of this phenomenon, however, there is lacking the positive determination of *how early* it appears among the symptoms of tabes; where, under what circumstances, in what other diseases it is present; and what particular accidental circumstances, perchance, accompany it, etc. Fur-

ther statistical investigations concerning its frequency, particularly in tabes, would also be desirable.

Since my last publication, above mentioned, I have followed this subject uninterruptedly, and now present again eighty-four new observations of typical tabes, collected since that time at all stages of the disease, mostly, however, from the earlier stages, in which the symptom was more carefully considered; besides, I have followed the same, as far as possible, in other diseases, and in healthy persons.

The best method of testing this phenomenon I have given in my essay cited above (p. 32). I only repeat here, to emphasize, that confusion of accidental accommodative movements with contractions of the pupils, has to be guarded against in particular. It is, therefore, not advisable to test the reaction to light by opening and closing the lids, but it is preferable to inspect the pupils attentively while the eyes are alternately shaded and illuminated. With the same caution it is also expedient to use, by means of a convex lens, natural or artificial light, for the purpose of examination, by which, oftentimes, traces of reaction are discovered which were not recognizable by ordinary illumination.

The results of my observations are as follows:

In 84 cases of tabes dorsalis, absolute reflex immobility occurred 59 times; very weak, slow, and inexpansive reaction to light, 12 times; hence, a total of 71 cases with diminished reaction, against 13 with normal reaction. Expressed according to percentage, a more or less high degree of reflex immobility of the pupils was present in 84.5 per cent. of my cases of tabes, and absent in only 15.5 per cent. Out of these 71 cases there were 3 in which the reflex immobility was unilateral, and 7 in which more or less marked optic nerve atrophy existed. Only 37—that is, 52 per cent.—were associated with decided myosis; and of normal-sized, with,

at the same time, somewhat unequal pupils there were 34 cases. Myosis, therefore, is not, at all events, regularly associated with reflex immobility, but fails in fully one-half the cases. Among the 37 cases with myosis were 8 with optic nerve atrophy. Out of the 71 cases, 43 belonged to the initial stage—that is, they exhibited no signs of ataxia, or only the slightest traces of it. The remaining 28 cases belonged to the ataxic stage—meaning, that they came under observation for the first time after having presented the phenomena of ataxia for a longer or shorter period. From the latter group of cases certainly no conclusions can be reached respecting the commencement of the disease, and the former are not much more conclusive, for the initial stage often lasts extraordinarily long—twenty-five years or more. At the same time, this symptom *may* appear very early in the course of the disease. In a complete series of cases I have seen it after a duration of the disease of from two to three years, and in one case each, after one and a-half years, one year, eight months, and six months. On the contrary, I have also seen it absent after the disease had continued for five, six, and ten years; in one case even after nineteen years! It does not, therefore, *necessarily* appear, but may be completely absent during the whole course of the disease. Yet, notwithstanding this, it belongs manifestly to the phenomena which are presented with the greatest regularity in tabes, and appear in the majority of cases very early.

It seemed to me of particular interest to test in what relation the reflex pupillary immobility possibly stood to that which is so important in the etiology of tabes, viz., syphilis; all the more, since in several cases of syphilitic infection I had seen that symptom appear alone, and as the percentage of cases of tabes presenting reflex immobility in the course of the symptoms, and of those presenting

syphilis in their previous history,' were nearly the same, the thought occurred that perhaps the reflex immobility and the myosis might appear exclusively, or predominantly, in those patients with tabes who had formerly had syphilis. The facts teach that this idea is not correct, for, from a review of my case-book, I find nine cases of tabes without previous syphilis, in which, at the same time, myosis and reflex immobility were present; and on the other hand, ten cases in which these phenomena were absent, although syphilis had preceded the development of tabes. A closer causal connection, therefore, between syphilis and reflex pupillary immobility does not appear to exist.

Concerning the occurrence of pupillary phenomena in progressive cerebral paralysis, I am not in a position to furnish much material, and even that little which I have observed myself, can claim no great worth, as, naturally, only those cases presenting few mental disturbances at the very beginning of the disease come to me. I have notes on 16 such cases, among which appeared all possible pupillary changes; in 2 cases only, nothing abnormal was to be found. In 10 cases, on the contrary, inequality of the pupils existed; but of these there were 7 in which the reaction to light was not appreciably diminished, and only 3 in which equilateral reflex pupillary immobility existed. Finally, myosis, equilateral and with reflex immobility, was present in 4 cases.

These few observations, which, as already mentioned, relate to the early stages of progressive paralysis, confirm, therefore, not only the great frequency of pupillary changes in this disease, but also the predominance of pupillary inequality over the remaining changes, particularly over myosis, less over reflex immobility. Inequality of the pupils I found 10 times in the 16 cases; on the other hand, reflex immobility, 7 times—once on one side only. There

is nothing further to conclude, however, from this small number.

In consequence of the great interest which the symptom possesses relative to the early diagnosis of tabes, I have naturally directed my attention to the presence of this disturbance in all manner of persons, and particularly to patients with diseases of all kinds. I have recently been able to demonstrate the existence of exquisite myosis, with reflex immobility, in patients not affected with tabes or progressive paralysis. A few of these cases may be reported here :

1. Male, æt. 45, born healthy, with anæmia in the highest degree (pernicious?), without any symptoms of tabes or other neurotic appearance, exhibited a very marked bilateral myosis with reflex immobility, together with distinct accommodative mobility. Under atropine the pupils dilated slowly and moderately.

2. Male, æt. 55, affected for many years with tremor, and all sorts of vague, neurotic disturbances—perhaps from chronic nicotin intoxication—had myosis with reflex immobility and retained accommodative mobility.

3. Male, æt. 33, twelve years previous had syphilis, has now mydriasis and paresis of accommodation of the right eye ; in the left eye decided myosis, and bilateral reflex pupillary immobility. Except unusual fatigue of the legs has no trace of other tabetic symptoms.

That these patients will not develop tabes later, who will dare to say ?

I have seen, besides, though rarely, this symptom in one or both eyes, in several other cases of neurotic disease, belonging mostly to central affections difficult of determination, but which could neither be classed with tabes nor progressive paralysis.

It is known, further, that in diseases or injuries of the cervical sympathetic, myosis appears, but, at the same time, the reaction to light is apt to be retained. The same holds true for lesions in the cervical region of the spinal cord.

The question is very important, finally, whether myosis with reflex immobility appears in healthy individuals. I have not, as yet, seen it. The presence of myosis is certainly very common in aged people, and even in a great number of young persons, who present absolutely nothing pathological; but I have never seen reflex pupillary immobility associated with it, and can confirm the assertion of Hempel, that in uncomplicated senile myosis the reflex reaction of the pupils to light is preserved.

The facts teach, therefore, that the symptom, reflex pupillary immobility, with or without myosis, is excessively frequent in *tabes dorsalis* and progressive paralysis; appears very rarely in other neurotic and in all other diseases; and apparently not at all in healthy individuals.

In order to understand correctly the value of this symptom and its signification in *tabes*, it is necessary to investigate its pathologico-anatomical and pathologico-psychological foundation somewhat more closely; for, evidently, this symptom, which appears so early and so regularly, is of the greatest interest for the understanding of the early localization of *tabes* so frequently in the region of the cranial nerves and the superior part of the cervical cord.

Entering upon the nature of the manifestation more closely, we are taught at once that we have here—and this point has also been developed by former observers—two things to be separated, differing from one another according to their nature and localization, namely: myosis, and reflex pupillary immobility.

Simple and daily demonstrable facts show that these two phenomena are by no means invariably associated; that reflex immobility can exist, now with, now without myosis; that it may appear in normally, or even in abnormally dilated pupils; and that, on the other hand, myosis very often occurs without reflex immobility—for example in healthy

persons, and with lesions of the sympathetic—showing that we have to do with two different sorts of phenomena, which are to be referred to different pathological factors. Indeed, it is easily possible, according to principles of current views concerning the innervation of the iris, to represent, schematically, a picture of when, and how the two disturbances may occur.

Between the retina and the sphincter pupillæ, innervated by the oculomotorius, exists a reflex tract, which goes through the optic nerve to the brain, within the brain to the oculomotorius, and in this, centrifugally to the iris. The reflex connection between the optic and oculomotor nerves within the brain takes place, probably, through the central apparatus intercalated in these nerve tracts. In explanation of the reflex immobility we can only maintain that that portion of the reflex tract is affected which lies between the optic and oculomotor centres just described, for, if the lesion were located in the peripheral optic tract, then the vision could not remain normal; while, if the peripheral oculomotor tract were the seat of the lesion, the pupils could not contract from accommodative impulses. We must, therefore, consider that small portion of the reflex tract—the location of which needs in many respects to be more exactly determined—as the diseased part whence originates the reflex immobility.

For the myosis we must refer to changes in the dilatator pupillæ, whose centre is said to be in the medulla oblongata, and sends the principal part of its mass in the cervical cord down to the cilio-spinal centre. A spasm of the sphincter cannot well be conceived with retained accommodative movements, and with a duration of the condition for many years. The tone of the dilatator pupillæ is controlled and regulated from those centres, it appears, partly by reflex excitations conveyed to them through the posterior roots

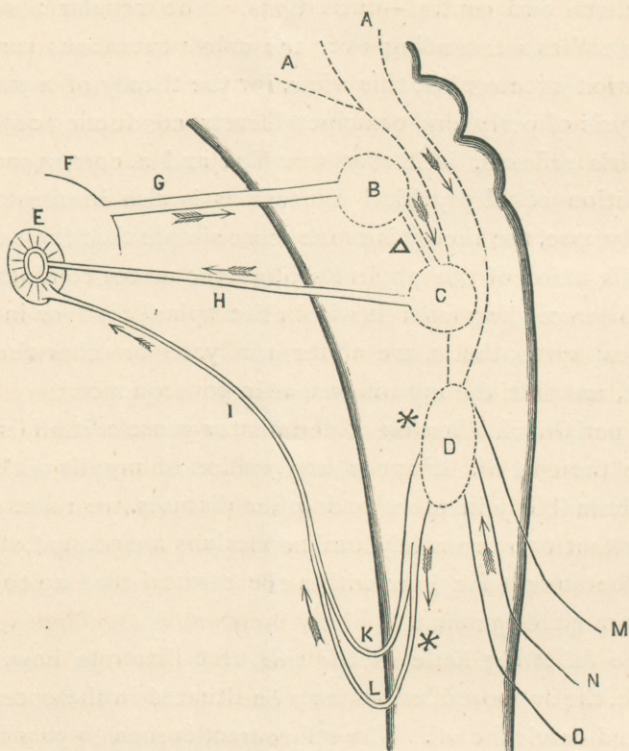
from the periphery of the body, and partly from the brain, through psychical and other excitations. The centrifugal tracts which extend from this centre to the dilatator pupillæ lie, as is well known, principally in the cervical sympathetic. It is scarcely to be maintained that the myosis of tabes should result through the removal of *all* these centripetal—peripheral and central—excitations. The regular absence of anæsthesia extending over the *whole* cutaneous surface speaks at once against this view, for the theory of a partial paralysis of peripheral centripetal tracts, conducting centripetal iris reflexes, is hardly tenable; and a corresponding inhibition of all psychical excitations is also unacceptable. In any case, the theory is much more simple that the centre for dilatation of the pupils itself, or the motor conduction-tracts proceeding from it within the spinal cord or in the cervical sympathetic, are either paralyzed or otherwise injured, and that the myosis results in consequence.*

A peripheral affection of the dilator muscle itself is not to be thought of. For the explanation of myosis with reflex immobility in tabes and other diseases, we must conclude that two separately localized lesions are present, which may be sought for from within the cervical cord up to the corpora quadrigemina.

The following little sketch will best illustrate how, and where, the supposed lesions may be situated in the encephalon and cervical cord. The reflex tract is seen to pass from the retina, through the optic nerve to the centrum optici, from this to the centrum oculomotorii, and through the oculomotor trunk to the sphincter pupillæ. The small triangle (Δ) indicates that point of the reflex tract where the lesion which leads to reflex pupillary immobility is to be

*G. Bessau (or Besau?) who, under Grünhagen's direction published an experimental essay on "pupillary contraction in sleep and diseases of the spinal cord" (Dissert. Königsberg, 1879), which I have been unable to obtain in the original, states that this view cannot be correct. Why his experiments forced him to this conclusion is not made clear to me from the report in the *Centralblatt für Augenheilk.*, Dec., 1879; June, 1880.

looked for. Elsewhere the centrum dilatatorium (cilio-spinal) is seen, which conducts centripetal excitations in part from the brain (psychical influences), in part through the posterior roots from the periphery of the body (sensory impressions), and whose centrifugal tracts (for dilating the pupils) leave the spinal cord through the anterior roots, in



AA. psychical impressions; *B.* centrum optici; *C.* centrum oculomotorii; *D.* centrum dilatatorium; *E.* iris; *F.* retina; *G.* optic nerve; *H.* oculomotor (sphincter); *I.* sympathetic (dilator); *KL.* anterior roots; *MNO.* posterior roots; Δ seat of lesion causing reflex pupillary immobility; * probable seat of lesion causing myosis.

order to reach the dilatator pupillæ through the sympathetic going to the iris. The asterisks indicate the places where lesions might produce myosis.

In order to further test the correctness or incorrectness of the theory, I have arranged, with the aid of my assistant

at the Polyklinik here, Dr. Kast, a series of experiments on my patients and a number of healthy persons, based upon various well-known facts, the results of which, being possibly of importance, I will briefly report.

The action of atropine was first tested on a number of tabetic patients with myosis and reflex immobility, and also on the two patients mentioned above, with the same affection. With all, dilatation of the pupils took place after instillation of atropine, though slowly and not quite as decidedly as in healthy persons. The same thing has been observed by Argyll Robertson, Leber, Hempel, Vincent, and others. According to Vincent, eserine produces a still greater contraction of the myotic pupil.

It is a recent though frequently studied fact^s that in a condition of normal sleep a high degree of physiological myosis exists, but at the moment of waking a considerable dilatation of the pupil follows, after which it returns to the medium size. The same experiment was made upon a tabetic patient, with myosis and reflex immobility, in my wards in Heidelberg. During sleep the patient's eyelids were gently drawn apart, and he was awakened by calling, and simultaneously pinching the skin—a double excitation; his pupils remained absolutely immovable and highly contracted. It is known, in addition, that through lively irritation of the skin in a waking condition, as well as during normal sleep, and also in sleep from chloroform, a dilatation of the pupils will be brought about. Based on this fact, I began a series of experiments, the results of which, up to the present time, I will communicate briefly.

If to a healthy person—his face being illuminated, and his eyes quietly but persistently fixed on a more or less shaded object—a strong cutaneous irritation be applied to the skin of the back of the neck, the mastoid process, the breast, the cheek, or the back of the hand, by means of

X | the faradic brush, for example ; the other—moist—electrode resting on the sternum, there follows after a short but distinct interval a more or less considerable slow dilatation of the pupils, which remains for a short time after the removal of the excitant, then slowly returns to its previous condition. The same thing occurs when, instead of using electricity, we sharply pinch a fold of the skin. By repeating the irritation several times in rapid succession, the action becomes visibly weaker, and finally ceases entirely ; after a short rest, however, it appears again. Irritation in the region of the cervical sympathetic by means of moist electrodes and the faradic current, also calls forth dilatation of the pupils. It has not been possible for me to decide, as yet, whether this occurs through direct irritation of the sympathetic, or in a reflex manner from the skin or deeper tissues. In patients with tabes, on the contrary, presenting reflex immobility, and usually myosis also, all reactions of the pupils are absent. With the strongest possible irritations of the skin to an unendurable degree with faradic brushing, as well as the sharpest pinching, and even with direct irritation in the region of the sympathetic with moist electrodes, not a trace of pupillary dilatation appears. I have also had an opportunity of examining a patient with tabes having the most marked spinal myosis with reflex immobility, at a time when he was being tortured by the most fearful neuralgic pains of the intercostal nerves and the lower extremities. During the attack of pain the pupils remained as before, not showing the slightest change. On the other hand, in cases of tabes with preserved pupillary reaction—and in these myosis is usually absent—dilatation of the pupils follows cutaneous excitation as in health.

I have not been able, thus far, to examine sufficient material to decide whether this non-dilatation, after cutaneous

irritation, is more closely connected with myosis, than with reflex immobility. This will be the next problem for investigation. So much, at least, follows from my experiments, that in tabes, there is not merely an abolition of reflex *contraction* of the pupils, but often an abolition of their reflex *dilatation*.

As until now these two phenomena appear to have been regularly associated, the title, "reflex pupillary immobility," chosen by me, is, in a double sense, correct. It applies to the reflexes from light, as well as to the skin reflexes; to the reflex contraction, as well as to the reflex dilatation of the pupils.*

The question whether these facts make a true anatomical and functional relation between (*sit venia verbo!*) *contraction* and *dilatation centres* for the pupils probable, will be left to the discussion of physiologists, and for decision by means of future experiments.

In other forms of disease I have made similar experiments. In a case of Basedow's disease without abnormalities of the pupils, dilatation appeared on cutaneous irritation. In a case of bilateral mydriasis with complete pupillary immobility, and with paresis of accommodation, probably dependent upon syphilis, all reaction from the skin failed at first, but, after a time, the contraction of the pupils to light returning, the dilatation on cutaneous irritation again appeared. In another similar case (No. 3), formerly syphilitic, with, on the left side, very marked myosis and reflex immobility, and on the right, mydriasis, with reflex and accommodative immobility, irritation of the skin failed to develop the slightest trace of reaction. On the other hand, in one case of unilateral amaurosis from neuritis retro-bulbaris, in which, on this side, reaction

* One may speak, therefore, of abolished pupillary reflexes. Is this not analogous, probably, to that constant and important symptom in tabes, the absence of the tendon reflex?

to light failed completely, slight dilatation, equal on both sides, was obtained by faradic brushing.

I would consider it entirely too precipitate to draw any conclusion from these few facts, respecting the complicated mechanism for the innervation of the iris, and the more exact nature and localization of the lesions in tabetic myosis with reflex pupillary immobility. These facts are only intended as the very beginning of a more exact investigation of the interesting relations of the pupils in tabes, and in other diseases.

It would be easy to fill many pages with theoretical speculations concerning the various possibilities which might be taken into consideration, in the highly intricate mechanism for the innervation of the iris, and in the pathology of the doubtful pupillary phenomena as well.

It is far from my intention to apply these considerations here, which really could have no other use than to suggest a search for, and the determination of, new facts. Such suggestions will force themselves upon whomsoever will earnestly occupy himself with this interesting subject.

First of all, it appears to me necessary to collect more facts, and to subject the normal as well as the pathologically changed pupils to still further variously modified experiments, in order to obtain a deeper insight into the nature and individual conditions of their disturbances.

It must be determined, first, according to my opinion, how the pupils behave in myosis with preserved reaction to light, as, for example, in the aged, and in many healthy persons; further, how they react in artificial myosis produced by calabar; then, whether with tabes with reflex immobility but *without* myosis, the case is different from that *with* myosis, and whether, also, the reflex excitability from the skin only fails in preserved reflex immobility; or, again, whether it has anything more to do with myosis; finally,

this question will be suitable for an experimental investigation on animals, in which, through Bessau's dissertation, a beginning worthy of attention has been made.

After further manifold studies we will finally be in a position to estimate more exactly the meaning of the pupillary phenomena treated of here in certain disorders of the central nervous system, especially in tabes dorsalis; but to-day, also, this symptom has a diagnostic worth not to be undervalued. It will aid in many cases for the more certain differentiation between beginning tabetic disease, and purely functional disorders, as, for example, neurasthenia, hypochondriasis, etc.

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