organisms found in the blood and other fluids of the body in these cases, at the same time giving the results obtained by inoculation with them.

In concluding his lecture, Dr. Greenfield said that out of the eleven cases at which he had worked, four were of malignant pustule, two of which were fatal, and six of fatal internal anthrax. Rodents were inoculated from eight, but results were only obtained in four instances, although the presence of bacilli was microscopically demonstrated in the fluids and tissues of all the fatal cases. This apparent discrepancy—which might tend to throw discredit on the diagnostic value of microscopic examination—is at once explained, when the length of time which elapsed between the death and the inoculation experiment is considered. For it is well known that when decomposition has set in before the *post mortem* examination is made, it is exceptional to obtain positive results by inoculation with the blood or other fluids. From this fact, and the delay which necessarily attends *post mortem* examinations, he was not at all surprised at the negative results he obtained from his earlier experiments; and consequently urged strongly the necessity of making early examinations of the body. The consequence of this was, that the inoculations made from later cases were all successful. In all cases, the intensity of the poison was proportional to the shortness of the interval between death and the examination of the body.

ON THE QUANTITATIVE ANALYSIS OF DIPLOPIC STRABISMUS.*

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THE operation for strabismus is very easy to perform; but the indications for operative interference, as well as the accurate determination and adjustment of the effect required, present very great difficulties. In order to avoid mistakes, a quantitative analysis of strabismus, before and after operation, seems to be required.

The basis of such an analysis is contained in Albrecht von Gräfe's first and classical paper on the Paralysis of the Obliquus (Gräfe's *Archiv*, vol. i, 1854). The method adopted now by all observers for cases of binocular diplopia (in concomitant and paralytic strabismus), is well known. One of the patient's eyes is covered with a red glass; both eyes being open, the patient is ordered to look steadily at the flame of a candle, and to indicate the respective positions of both the subjective images of the flame, and that for various positions of the object in the field of fixation. The method is based upon the patient's subjective measurement of the reciprocal distances of the images. To render the results more apparent, some authors have introduced diagrams or divisions. I quote first from Mr. Bader's Text-book (1868, p. 440): "We place the patient, with the head fixed, facing a black board. The latter stands parallel with the patient's face, about five feet, and is divided into squares which are numbered. The flame of the candle is then moved in horizontal, vertical, and oblique directions from the median line; and the two images of the flame, the one of the properly directed, and the one of the deviated eye, are perceived opposite different squares of the board."

A similar division of a wall into squares of 0.25 mètres in length was adopted by Heiberg of Christiania, in 1872 (*Ophthalmological Methods*, Christiania, 1875; also, *Centralblatt für Augenheilkunde*, 1880, p. 132).

This method was improved at the same time by Dr. E. Landolt of Paris (*Annales d'Oculistique*, July, 1875. See also, *Leçons sur le Diagnostic des Maladies des Yeux*, Paris, 1877); and by myself (*Verhandlungen der Physiologischen Gesellschaft*, July, 1875; Knapp's *Archives*, vol. iv; *Beiträge zur Prakt. Augenheilkunde*, i, ii, iii); and instead of longitudinal distances an angular division was introduced. This innovation is not a trifling one, as it may at first appear, but rather essential for our purposes, as in the perimetry of the visual field (Diagram 1). For a normal pair of eyes the common field of fixation is a portion of a spherical surface, A, S, B. The central point, M, of the sphere coincides with the middle of the base line, which joins the centres of rotation, D₁ and D₂, of both eyes; the radius, M. S., of the sphere may have any length desired. v, We chose a radius of two mètres. The plane, D₁, D₂, s, coincides with that of the primary position of the eyes, viz., horizontal; the head being upright. s is the pole of the common field of fixation. Only that part as A, B, of this field which corresponds to an angular aperture of $2 \times 40^\circ = 80^\circ$, is generally touched by the point of intersection of both visual axes. For that part alone, Listing's law of rotation is valid. Patients with binocular diplopia are always satisfied if you succeed in obtaining for them single vision over a normal space of perhaps $2 \times 30^\circ = 60^\circ$. For that part of the common

field of fixation, you must examine in every pathological case the character of the diplopia. Diplopia is practically less troublesome in reading than in walking; I therefore preferred to test the binocular diplopia for a greater distance of the fixed point or object, viz., at the distance of two mètres, and projected, according to a simple calculation, which may be found in my paper in Knapp's *Archives*, the division of the field of fixation in degrees upon a wall of my consulting-room, by a system of crossed co-ordinate lines. The middle point of the system has an elevation from the bottom of 1.6 mètre. By a simple chin-holder the head of the patient may be fixed at such a height, that the base line has almost the same elevation of 1.6 mètres. The patient's head may be held gently by an assistant, so that his frontal plane is vertical. Both eyes being open, the right eye is covered with a thin red glass plate, the patient is ordered to fix the flame of a small wax candle, held at the middle point of the system of co-ordinates, and to determine both the horizontal and the vertical distances of the images, the yellow one and the red one. The algorithm for quoting the result is very simple: o, o : +3° - 1° signifies that there is for the primary position of the eyes homonymous diplopia, the horizontal distance of the two images being 3°, the depression of the red image being 1°; o, o : -3° + 1° indicates that there is for the primary position of the eyes a crossed diplopia, the horizontal distance between the two images being 3°, the elevation of the red image being 1°.

Half a degree is very easily estimated by intelligent patients. But the practical unity concerned in squint operations is of ten degrees; that is to say, if the horizontal strabismus is less than ten degrees, generally you may avoid operating. Now a rotation of the visual axis of ten degrees is equal to a dislocation of the corneal centre of 1 millimetre, scarcely visible to the naked eye of the observer. Ten degrees seen at a distance of two (or one) mètres corresponds to the linear quantity of 175 (or 352) millimètres. The distance between both eyes, or the length of the base line (equal to two inches), gives rise to but a trifling parallax, which may be neglected for a distance of six feet. That is the mathematical basis for our arrangement.

The same measurement is made for some principal points of our angular division. You move the candle flame 20° to the right hand, in a horizontal direction; then 20° to the left; 20° directly upwards; 20° downwards; and, finally, in diagonal directions to the points, +xx + 20; +xx - 20; -xx + 20; -xx - 20. For every one of these nine points the degree of diplopia is tested and noted (the head of the patient being gently held, and only the eyes allowed to move). Noting all results upon a card, you see at a glance the various positions of the visual axis of the fixing eye. You thus obtain a certain result in degrees, and have the opportunity of comparing the results obtained in the same case at different times or phases of the disease; or in different cases of the same kind (viz., of myopic convergence, which is generally associated with binocular diplopia). We may thus establish some definite rules; such as, what degree of homonymous diplopia is corrected by simple tenotomy of the internal muscle; or of crossed diplopia by an advancement of the internal muscle. One important point is to avoid tiring the eyes (that is, increasing diplopia), in cases of fresh paralysis,

* Read in the Section of Ophthalmology at the Annual Meeting of the British Medical Association in Cambridge, August 1880.

by interrupting the examination, shutting the patient's eyes for half a minute, or renewing the test in the opposite direction.

You may ask, Why do you not test the degree of diplopia by the correcting prism? By the use of prisms two sources of error are introduced. The first is a faulty position of the prism; the second and more important is the tendency to the fusion of the two images. I have published in Knapp's *Archives* a large series of experiments with prisms, and will submit to your judgment only a few instances. I recede from the wall eighteen inches, and cover one eye with a prism of six degrees, the angle being upwards. At first the deviation of the image is equal to 3° , after a few seconds, it is equal to 2° , and shortly it becomes zero. That is to say, single vision is obtained by the tendency to the fusion of both the images.

I have shown my arrangement to a great number of distinguished colleagues, who have visited my clinic during the last four years. They have all approved of it, but have not introduced it in their practice, because it seemed to be hard work to draw with one's own hands such an angular division upon a wall. Last year, I ordered my divisions to be made in the shape of a map, which may easily be hung in a consulting room. For that purpose, the visual distance is now reduced to one *mètre*. But if you prefer two *mètres*, you have only to take the half of every number; as for instance for 40° which is written, you take 20° . I have made some hundreds of measurements with my diagram, and submit for your consideration some illustrative cases, firstly, of paralytic diplopia (Cases 1 and 2).

After this theoretical and naturally tedious introduction, I may proceed to the practical part, stating the advantages of a more particular measuring of the degree of binocular vision in different cases.

1. Such a systematic and numerical examination of diplopia helps us to detect the slightest degree of paresis of an ocular muscle, and make a sure diagnosis.

2. You may superintend the results of the treatment of the paralysis of the muscles of the eye. Electricity is, for instance, considered by some authors to be a strong remedy in such cases. Immediately after every application of the galvanic current, the distance of the two images is said to be lessened. In the same manner some recommend the mechanical rotation of the paralysed eye, with a pair of forceps, outwards in a case of paralysis of the rectus externus, for instance; I cannot state any advantages of such proceedings; the degree of diplopia being the same before and after the application. I treat of course the simple, or so-called rheumatic paralysis of the eye muscles, with electricity, because the treatment is harmless, and patients will be treated; but success is not visible nor very credible, because it is impossible to irritate a single muscle of the eye by the common apparatus with the constant or induced current.

3. In a great number of common hypermetropic squints, with amblyopia of the squinting eye, the operation is rather a cosmetic one. There is generally no diplopia.* There is generally no fear of over-correcting by a single and simple tenotomy. But you must be careful before performing the second operation, so as to avoid secondary divergence. In several cases of ordinary convergence, I could elicit diplopia after the first operation, and measure the degree; so I had a certain basis for the second operation, better than may be obtained by simple inspection of the eyes (Case 3).

4. In cases of myopic squint, binocular diplopia is generally present. The correction must be not only cosmetic, but rather physiological. The task is not very easy without a careful examination. *a.* Myopic convergence is a less frequent form of squint, but well known to every colleague. The patients come for the diplopia; the squint begins in youth, not in childhood (Case 4). In other cases of myopic convergence, it is better to avoid operation (Case 5). *b.* Myopic divergence is, after the common hyperopic convergence, the most frequent form of strabismus, and generally associated with diplopia. As I have seen several cases of that kind operated on by the most experienced surgeons, and, notwithstanding, followed by artificial convergence, I insist upon a careful examination of the diplopia before and after operating, in order to avoid over-action (Cases 6, 7, and 8).

5. Secondary strabismus, for instance divergence following an operation for convergence, is a very interesting form, particularly if you are not the author of it, but the corrector. The enormous divergence after the old Dieffenbach's myotomy, now met with only in old people of course, is to be left alone, or corrected only by re-adjustment of the divided muscle, if possible. The divergence sometimes occurring after the modern tenotomy is so strong that you may consider an advancement necessary, but sometimes a simple tenotomy of the antagonist may

suffice. That is naturally a great advantage, acquired by a careful examination during all steps of the proposed operation (Case 9).

7. Every case of paralytic strabismus is associated with diplopia, unless one eye becomes amaurotic or amblyopic. [I remember a case of reputed cure of diplopia by electricity, but the neurologist physician had overseen the monocular amaurosis which had meanwhile crept in. A few weeks ago, I saw a similar case. A man, aged 40, was attacked, fourteen years ago, by paralysis of the left externus, with diplopia and headache; the diplopia decreased, but not the squint. I found the right eye normal; in the left paresis of the externus muscle, central scotoma with high amblyopia, partial atrophy of the optic disc; and naturally no diplopia.] The patients come rather for the correction of diplopia than for cosmetic purposes. Of course, you do not operate on such a case before all internal remedies have failed, and the time (from three to nine months), during which a paresis may disappear spontaneously, has entirely elapsed. Then, if you proceed to an operative correction, every precaution is necessary in order to avoid mistakes. Muscular power cannot be created by any squint operation, but only distributed in another and more satisfactory manner. For instance, in a paresis of the left externus muscle, when in the middle part of the field there is troublesome double vision, and only towards the boundary of the field is single vision, you may transfer the area of the single vision to the middle of the field, either by tenotomy of the antagonist (*viz.*, internus of the left eye), or by advancement of the paralysed externus, or by a combined method. But in these operations, a very peculiar correction is required; otherwise, you may introduce in a case with mere lateral diplopia, a more annoying form with vertical distance of the double images, which is much more dangerous in walking, particularly up and down stairs. Now we cannot make a mathematically correct advancement of a muscle, though some authors believe that they can cut with mathematical exactness. But we can test what we have done with mathematical accuracy, if we make use of an angular division, and abstain in such operations from anaesthetics. This is quite possible, because generally the paresis of the eye-muscle (except the congenital form) is found in adults. I can submit you an interesting case, in which the advancement of a paralysed rectus externus had introduced a slight, but annoying, vertical distance of the images, and this mistake was immediately shown by the examinations, and removed by renewing the stitches (Case 10).

8. Finally, I may allude to the slight, but troublesome, diplopia, remaining in some cases after paralysis of the upper oblique muscle. Some authors have succeeded in correcting this diplopia by a combined operation of tenotomy; but sometimes it seems to be wiser to make this difficult correction with prisms. Measuring the angular deviation of the paralysed eye with the apparatus, you have immediately the deviation and the strength of the correcting prisms, if you consider that the angular deflection of the ray caused by a prism is the half of the degree of the prism-angle. The correction must be perfect for the middle part of the field. Then the patients are very much satisfied if they acquire simple vision, simply by a pair of spectacles; and if they can abandon the exclusion of one eye, by means of a black glass, and its disfigurement (Case 11).

If I have submitted to you a paper, sent from abroad, in which some of you are perhaps unable to find anything new in examinations, indications, or operations, your indulgence will attribute it to the highly cultivated state of ophthalmological science, both in England and in other civilised countries, which renders it difficult to introduce perfectly new matter. But I dare believe that one point has been elucidated by my paper; and this is: the high importance of a more particular examination of diplopia, with an improved apparatus of angular division, and its advantages for ophthalmological science and practice.

APPENDIX OF ILLUSTRATIVE CASES.

CASE 1.—*Paralysis of the Superior Oblique Muscle of the Left Eye.*—The character of the diplopia in a case of paralysis of the superior oblique muscle of the left eye is as follows (after Albrecht von Gräfe's *Augenmuskellähmungen*; Berlin, 1867, p. 144).—The image of the left eye is lower.* In the median line, the two images are distinctly homonymous,† and slightly oblique (convergent upwards). If the object in the lower part of the field of vision be moved from the median plane to the left hand, both the lateral and the level distances decrease, but the obliquity increases. If, on the other hand, the object in the lower part of the field of vision be moved from the median plane to the right hand, the distance in height is very distinctly increased.

* Or that of the right eye is higher. In the diagrams, the second number always denotes the difference of height, and has in case 1. the sign +; *i.e.*, the image of the right eye is higher.

† Every first number gives the lateral distance of the two images, and has, in case 1, the sign +; indicating always that the diplopia is homonymous. For some points of the field of vision, to the left hand, there is no lateral distance; the first number is then zero.

* Von Gräfe has found that binocular vision is absent in about seventy per cent. of cases of concomitant squint; that we can produce diplopia by prisms in about twenty-five per cent.; and that after the operation, binocular vision is found to exist in about fifty per cent. (see Soelberg Wells' excellent text-book, p. 577).

	-30°	-25°	-20°	-15°	-10°	-5°	0	+5°	+10°	+15°	+20°	+25°	+30°
+XX	..	..	0	..	..	..	0	..	+4°, +1°	..	+1½°, +3°	..	+2°, +8°
+XV	..	..	0	..	..	..	0, +1°	..	+4°, +4°	0, +5°	+1°, +6°	..	..
+X	..	..	0	0, +1°	0, +2°	0, +2°	0, +2°	..	..	..	..	..	..
+V	..	..	0	..	0, +1°	0, +1°	0, +1°	..	..	..	..	..	..
0	0, +1°	+1½°, +½°	+½°, +½°	0, +2°	+1½°, +1°	0, +1°	+1°, +2°	..	+1°, +7°	..	+2°, +12°	..	+3°, +15°
-V	0, +1°	0, +2°	0, +2°	0, +2°	0, +1°	0, +1°	+1°, +2°	..	..	..	..	..	..
-X	..	..	..	..	+1°, +6°	..	..	..	+2°, +11°	..	+2°, +13°	..	..
-XV	..	..	..	+2°, +6°	..	..	+3°, +10°	..	..	+5°, +13°	..	..	..
-XX	..	..	+2°, +5°	..	+4°, +8°	..	+3°, +10°	..	+6°, +11°	..	+6°, +11°	..	+10°, +19°

[The numbers for some principal points of the field of vision are printed in thick figures.]

CASE II. *Paralysis of the Right Superior Oblique Muscle.*—A young lieutenant, who was treated by his surgeon, some years ago, for syphilitic patches of the lips and mouth, first complained, in May, 1879, of diplopia, with convergence of the left eye. The diplopia ceased in September, but returned, with headache, in January, 1880. The first examination of the diplopia, on March 12th, 1880, gave the following result:

	-20°	0	+20°
+XX	+1°, -2°	0	0
0	0, -11°	+2.5°, -3°	0
-XX	V°, -15°	+4°, -9°	—

Résumé.—Single vision towards the upper right quadrant of the field; largest distance of double images in the lower left quadrant; slight convergence; depression of the image of the right eye. Diagnosis: Paralysis of the right trochlearis. The patient was treated by iodide of potassium in full doses. The headache had diminished on March 18th. A second examination was made on April 1st.

	-20°	0	+20°
+XX	+2°, 0	+3°, 0	0, +1°
+X	—	0, +1°	0, +1°
0	+1°, -2°	+1°, -2½°	+0°, -2°
-X	—	+3°, -3°	+3°, -3°
-XX	+5°, -7°	+7°, 9	+3°, -5°

Résumé.—Area of single vision diminished; convergence increased, but vertical distance diminished. The treatment was continued; from June 5th, biniodide of mercury was added to a smaller dose of iodide of potassium. A third examination was made on June 5th.

	-20°	0	+20°
+XX	0, +2°	0	0
0	+3°, -5°	+5°, -½°	+5°, -½°
-XX	—	—	—

Résumé.—Single vision in the midst of the field and in the upper part; double vision only downwards remaining; the troublesome vertical distance only towards the lower left boundary of the field. The patient could do his work without exclusion-spectacles.

CASE III. *Paresis of the External Rectus Muscle of the Right Eye.*—Mr. M., aged 25, was taken ill on February 20th, 1875, with headache, giddiness, nausea, and diplopia. He came under my care on March 31st. I found neuro-retinitis of the right eye (Snellen CC at 20 feet; with +½°, Snellen 2½ at 7"), and paresis of the external rectus of the same eye. At first, both affections, and the headache, increased (with +½° Snellen 5). Under the application of Heurteboul's, and the internal administration of mercury, the symptoms decreased. He was discharged on June 3rd, 1875. The subjoined diagram shows the results of three examinations:

	-20°	-10°	0	+10°	+20°
+XX	—	—	+10°, 0	—	—
0	—	—	+10°, +1°	—	—
-XX	—	—	+½°	—	—
+XX	+5°, 0	—	+8°, +1°	+10°, 0	—
0	+5°, 0	—	+10°, +1°	+15°, +1°	—
-XX	—	—	0, 0	—	—
+XX	—	—	+9°, 0	—	—
0	—	—	+10°, +1°	—	—
-XX	—	—	0	—	—

CASE IV. *Common Hypermetropia: Convergent Squint.*—Alwine N., a girl, aged 17, had squinted with the right eye for twelve years. Hypermetropia = ¼; vision = 1 with the left eye, ½ with the right. On October 8th, 1875, tenotomy of the internal rectus muscle of the right eye was performed, with compensating suture. On October 13th, the convergence had increased, in spite of convex glasses; and on the 18th it measured five degrees at two metres distance, in the primary position. On the 21st, tenotomy of the internal rectus muscle of the left eye was done, with compensating suture. On November 19th, the convergence was very slight. There was spontaneous diplopia only towards the left boundary of the field of vision. With a red glass, the diplopia was, in January, 1876, only +1 for the primary position; the height distance remaining.

The first examination was made on October 18th, 1875, after the first operation.

	-20°	-15°	-10°	-5°	0	+5°	+10°	+15°	+20°
+XX	—	—	—	—	—	—	—	—	—
+XV	—	—	—	—	+4°, -6°	—	—	—	—
+X	—	—	+4°, -9°	—	—	+4°, -2°	—	—	—
+V	—	—	—	—	—	—	—	—	—
0	—	+5°, -8°	—	—	+5°, -5°	—	+5°, -3°	—	—
-V	—	—	—	—	—	—	—	—	—
-X	—	—	+8°, -4°	—	—	+6°, -2°	—	—	—
-XV	—	—	—	—	+7°, -2°	—	—	—	—
-XX	—	—	—	—	—	—	—	—	—

The second examination was made on January 4th, 1876, after the second operation.

	0	-20°	-15°	-10°	-5°	0	+5°	+10°	+15°	+20°	0
+XX	—	—	—	—	—	—	—	—	—	—	—
+XV	—	—	+8°, -13°	—	—	0, -5°	—	—	-2°, -1°	—	—
+X	—	—	—	—	—	—	—	—	—	—	—
+V	—	—	—	—	—	—	—	—	—	—	—
0	—	-9°, -15°	—	-2°, -7°	0, -7°	+1°, -2°	+1°	—	—	+½°	0
-V	—	—	—	—	—	—	—	—	—	—	—
-X	—	—	—	—	—	—	—	—	—	—	—
-XV	—	—	+2°, -5°	—	—	—	—	—	+½°, -½°	—	—
-XX	—	—	—	—	—	—	—	—	—	—	—

CASE V. *Myopic Diplopia Converged cured by Simple Tenotomy.*—Anna P., aged 25, had been myopic from infancy; but, for the last six years, had been also troubled with diplopia both in walking and in reading. She had been ordered to wear, in walking, prism 7° (base outwards) before the right eye; and, in reading, concave glasses; but without any benefit. In March, 1875, I found: myopia ½ - ¾; with the right and left eyes she could read Jäger 1 at five inches, with -5°, Snellen XXX, at twenty feet; but not also Jäger 2; with -6°, Snellen XL at twenty feet, and Jäger 1 at six inches. There was concomitant convergence, stronger for distant objects, less for nearer, ceasing at five inches distance from the eye. If the flame of the candle were brought (without red glass) in the horizontal median line, to the distance of ten inches and nearer, the double images became confluent. At the reading distance, equilibrium was found under a prism refracting upward. The patient had some adducting power in reserve. Tenotomy of the internal rectus muscle of the right eye was performed on March 10th, 1875. Examinations were made before the operation, immediately after operation, on the following day, and on March 13th, April 26th, July 10th, and December 8th, with the following results. The examinations before and immediately after operation were made at a distance of two metres from the object, without the red glass; afterwards, at the same distance, with red glass.

On March 11th (the day after the operation), in the horizontal median line, the candle-flame was seen single at distances varying from one hundred to five inches. The patient reads at six inches without diplopia. With the naked eye, there was no diplopia after April 26th; a faint trace of dynamic divergence at the reading distance remained, but without any asthenopia.

Position of Object.	Before Operation.	Immediately after Operation.	March 11.	March 13.	April 26.	July 10.	Dec. 8.
+40°, 0	—	—	+11°, 0	—	—	—	—
+30°, 0	—	—	+9°, 0	—	—	—	—
+20°, 0	—	+11°	+9°, 0	+9°, 0	+1°	+1°	+1°, +1°
+10°, 0	+11°, 0	+3°	+4°	+1°, +1°	0	+1°	0
0, 0	+11°, 0	0	0	0, 0	0	0	0
-10°, 0	+11°, 0	0	0	0, 0	0	0	+1°, +1°
-20°, 0	+11°, 0	0	0	0, 0	0	0	0
-30°, 0	—	—	—	—	—	—	—
-40°, 0	—	—	—	—	—	—	—
0, +XX	+11°, 0	—	+1°, 0	+1°, 0	+1°	+1°	0
0, -XX	+11°, 0	—	+1°, 0	+1°, 0	+1°	+1°	0
+20°, +XX	—	—	+2°	—	+2°	+2°	—
+20°, -XX	—	—	+9°	—	+2°	+1°	—
-20°, +XX	—	—	0, 0	—	+1°	0	—
-20°, -XX	—	—	-0°, +1°	—	+1°	+1°	—

* A really concomitant convergence.

† Single vision.

In this case, convergent myopic strabismus (11°), with troublesome diplopia, was lessened by simple tenotomy and protracted rest of the eye. It finally became imperceptible with the free use of the eyes, and was only demonstrable with a red glass in the most excentric parts of the field of vision.

CASE VI. *Myopic Convergence cured by Glasses.*—A young lady, aged 18, complained of myopia and diplopia. Snellen 1½ was read at nine inches. The diplopia was examined with a red glass, the object being one metre distant.

	-20°	0	+20°
+XX	—	+17°, +5°	—
0	+15°, +2°	+15°, +2°	+14°, +2°
-XX	—	+17°, 0	—

Without a red glass, 0, 0 : +5°, 0. Without a red glass, but with -14" (concave), 0, 0 : 0. (*i.e.*, single vision). For near sight was given, concave thirty inches; for far sight, concave, fourteen inches. After a few weeks, the diplopia was diminished; and the patient's complaints were relieved.

CASE VII. *Myopic Divergent Squint, with Diplopia, cured by One Tenotomy.*—A lad, aged 14, came for myopia of both eyes and divergent squint of the right eye (1876). The left eye saw Snellen 1½ at 4 inches, and with concave glass 8 (inches) Snellen XXX at 15 feet. The right eye saw Snellen 2 at 4 inches, and, with -8", Snellen C at 15 feet. For the primary position, there was divergence of 14" (0, 0 : -14" +1"; the object being two metres distant). If the object were removed to 20 feet, there was crossed diplopia, not corrected by a prism of 20°. On July 14th, 1876, tenotomy of the right external rectus muscle was performed. Examinations after the operation, with a red glass, the object being two metres distant, gave the following results :

	July 5.	July 8.	July 14.	July 28.
-20°, 0	0	+3°	0	0
-10°, 0	0	—	—	—
-5°, 0	+2°	—	—	—
0, 0	+8°, 0	+13°	+3°	0
+10°, 0	+12°, 0	—	—	—
+20°, 0	>15°	+15°	+15°, -2°	—

Without the red glass, there was no diplopia at all, neither for near nor for far distances.

In this case, the convergence, after the operation, in the primary position, first increased, and then decreased, finally to zero. About 10° the left (*Electio-stellung*), there was no diplopia at all immediately after the operation.

CASE VIII. *Myopic Divergent Squint of high degree cured by a Combined Operation: Advancement of the Internal Rectus and Tenotomy of the Internus.*—Hermann S., aged 23, a clerk, came, June 26th, 1876, for divergence of the right eye. The latter was measured to about six millimetres, if an object in the median line, at the distance of two feet, were fixed. There was no diplopia; perhaps because the image fell on a very excentric part of the squinting retina. The right eye read Snellen

1½ at 3 inches; the left at 12 inches. On June 26th, advancement of the right internal rectus muscle was practised. On the 30th, the diplopia was measured : 0, 0 : -15°, -6°. On July 1st, tenotomy of the right externus muscle, with compensating suture, was performed. A slight degree of divergence remained, but disappeared as soon as the compensating suture and the superior stitch of the advancement were taken off. The following results were obtained from examinations made after operation.

	July 2.	July 7.	July 10.	July 15.
-30°, 0	+2°, 0	+3°, 0	—	—
-20°, 0	+5°, -5°	+8°, -3°	0	0
-10°, 0	+11°, -10°	+7°, -5°	+5°, -5°	0
+20°, 0	—	—	—	—

The result was binocular vision through the whole field of vision, and also for reading. The same condition remained at the end of three years.

CASE IX. *Myopic Divergence, with troublesome Diplopia, cured by Tenotomy.*—A young man came in August 1875 with divergent squint of the right eye, diplopia (-15°) with lower position of the second image, and asthenopia. Examination before operation gave the following results :

	-15°	0	+15°
+XV	-14°, +10°	-15°, +10°	-12°, +6°
+X	—	—	—
0	-11°, +10°	-15°, +10°	-12°, +3°
-X	—	—	—
-XV	-10°, +6°	-11°, +6½°	-8°, +6°

On August 4th, tenotomy of the right external rectus muscle was performed. Examinations after operation gave the following results :

	1875. August 5.	August 7.	August 12.	Aug. 17.	Nov. 3.	1876. Jan. 4.*	1876. Jan. 4.†
+20°, 0	+10°, +6°	+15°, +12°	+2°, +3°	-3°, +3°	—	-0°, +6°	0
-0, 0	-1½°, +6°	+1°	-2½°, +2½°	-6°, +4°	-5°, +4°	-5°, +5°	0
-20°, 0	-5°, 0	-1°, +1°	-3½°, +3°	-1°, +1°	-4°, +2½°	-4°, +2½°	0
0, +XV	-3°, +2°	0, +1°	+5°, +5°	+10°, +6°	-12°, +5°	-12°, +6°	0
0, -XV	+4½°, -2°	+7°, 0	-1°, +1°	-5°, +2°	-3°, +1°	-3°, +1°	0
+10°, +X	—	—	—	—	—	—	—
+10°, -X	—	—	0, 0	—	—	—	—
-10°, +X	—	—	-5°, +4°	—	—	—	—
-10°, -X	—	—	-1½°, 0	—	—	—	—

* When the object was fixed by the right (the operated) eye.

† When the object was fixed by the left eye.

Meanwhile, without a red glass, there was no double vision in the greatest part of the field. In reading, both eyes fixed the object; under a prism refracting upwards, there was a slight dynamic divergence.

Résumé.—A divergence of 15°, with depression of the second image (10°), and with troublesome diplopia, was diminished, by simple tenotomy of the external rectus, to -5°, +5°, and the remaining diplopia was subdued without fatigue by fusion.

CASE X. *Secondary Divergence after Division of the Internal Rectus, cured by Tenotomy of the Antagonist Muscle.*—Mrs. E., aged 25, had been operated on in the country fifteen years ago, for convergent squint of the right eye, by simple tenotomy of the right internal rectus muscle. For the last five years, she had complained of asthenopia and diplopia, and of increasing divergence of the operated eye. All these symptoms had increased during the last year, and had become very troublesome. The right eye was amblyopic (it counted fingers at 5 feet, and scarcely read Snellen XII at 6 inches). The ophthalmoscope showed hypermetropia of about 13" (= 3 D). The left eye was emmetropic (tested by glasses and by the ophthalmoscope), with normal vision. There was a high degree of divergence of the right eye, decreasing for farther distances. Examination before operation with a red glass, the distance of the candle being one metre, gave 0, 0 : -14°, +3°; +20°, 0 : -17°, +2°. After the first examination, advancement of the divided rectus internus, with tenotomy of the antagonist muscle, was proposed. In such circumstances, I generally begin with the latter; but, in this case, I was surprised by the strong action of the tenotomy of the rectus internus muscle; and, proceeding immediately to the examination of the diplopia, I found it decreased from 14" to zero (June 6th, 1880). I naturally abstained from all further steps, and bandaged the eye. The next day, I found single vision in the middle part of the field from -30°, 0 through 0, 0 to +30°, 0; only towards the boundaries of the field there was a slight degree of diplopia, crossed to the left hand naturally, and homonymous to the right hand : it was not observed by the patient without special

attention, and was seen distinctly only with a red glass. The patient was discharged a week after operation, with a satisfactory state of single vision. Examinations after operation gave the following results :

	July 27.	August 8.	August 12.
-40°	-10°, 0	—	-6°, -2°
-30°	—	-6°, 0	—
-20°	—	0	-5°, +1°
-10°	—	0	—
0	0	0	0
+10°	—	—	0
+20°	—	0	0
+30°	+5°, -9°	+5°, -5°	+5°, 0

Without a red glass there was single vision, if the candle-flame were in the median line and approached from 3 feet to 6 inches. At the ordinary reading distance (8 to 12 inches), both eyes fixed the object.

CASE XI. *Paralytic Diplopia (Paralysis of the Rectus Externus) treated by Advancement of the Paretic and Tenotomy of the Antagonist Muscle.*—Mr. C., aged 37, came on 5th April, 1875, with complete paralysis of the external rectus muscle of the right eye. The diplopia was typical, as follows :

	-30°	-20°	-10°	0	+10°	+20°
+XX	—	+12°	—	+25°	—	+40°
+X	—	—	+18°	—	+20°	—
0	—	+15°, -1°	+18°, -1°	+20°, -1°	+30°	+39°
-X	—	—	+20°	—	+31°	—
-XX	—	+15°	—	+27°	—	+45°

The paralysis ceased slowly and spontaneously. The resolvents, Heurteloups, and electricity, which were ordered, had no remarkable influence on the disease. There was no defect of motility remaining; but a strong convergence, in consequence of contraction of the antagonist muscle. Examinations made half a year after the commencement of the paralysis showed, on October 9th, +10°, 0: +35°; 0, 0: +32°; -10°, 0: +30°; and on November 27th, 0, 0: +29°. On December 27th, 1875, I proceeded to operative correction, and first performed tenotomy of the right internal rectus muscle, with suture. Examinations gave the following results :

	Immediately before Operation.	Immediately after Operation.	After taking off the suture.	Dec. 28, 1875: Day after operation.	Dec. 29, 1875.	Dec. 30, 1875.	Jan. 2, 1876.
+20°, 0	+35°	—	—	+28°	—	—	—
0, 0	+29°	+25°	+20°	+26°, -2°	+26°, -2°	+25°	+26°
-20°, 0	+25°	—	—	+10°	+4°	+15°	+19°
-30°, 0	—	—	—	0	0	+10°	+7°
0, +XV	—	—	—	—	—	—	+24°, +2°
0, -XV	—	—	—	—	—	—	+30°, -4°

On January 3rd, 1876, strong advancement of the rectus externus was done. Subsequent examinations gave the following results :

	January 3, 1876.		January 4, 1876.		January 5.
	Immediately after Operation.	After Loosening upper of 3 Stitches.	Without Red Glass.	With Red Glass.	
+20°, 0	+10°, -20°	+10°, -5°	+10°, -3°	+11°, -3°	+11°, -5°
+10°, 0	—	—	+10°, -2°	+11°, -1°	—
0, 0	+5°, -5°	+4°, 0	0	+6°, -1°	+6°, -1°
-10°, 0	—	0	0	0	0
-20°, 0	—	-10°	-5°, 0	-5°, 0	-5°, 0
0, +XV	—	—	+3°, +1°	+6°, +3°	+5°, +1°
0, -XV	—	—	+8°, -3°	—	+9°, -2°

Meanwhile, the adductor power of the diseased (right) eye had become even a little stronger than that of the other. Without a red glass, an object in the median line, slowly approached from 70 to 5 inches, is seen singly. Without a red glass and with Pour apparatus, the area of single vision reaches from 0 (or -5°, 0) to -20°, 0, and is larger in the superior part of the field. The case has been under observation from 1875 to the present time, and the good effect of the operation has been established. The patient, a lawyer's clerk, has been able to work at writing and reading, without asthenopia. His troubles, however, were not yet finished. Last year, paresis of the external rectus muscle of the left eye had appeared, and was cured by iodide of potassium. He now has single vision.

CASE XII. *Syphilitic Paralysis of the Left Obliquus Superior Muscle, with Myopic Divergence. Diplopia diminished by Antisyphilitic Treat-*

ment, and the remainder corrected by Prismatic Spectacles.—Mr. M., aged 48, with an old history of syphilitic infection, had an attack of diplopia, lasting for two days, about a year ago; and came with a fresh diplopia in February, 1880. He had been myopic from childhood (Snellen 1½ at 8 inches; with -8°, Snellen XXX at 15 feet). On February 11th, there was rather concomitant divergence, increasing upwards, combined with slight and recent paresis of the left obliquus superior. There was diplopia, crossed upwards, slightly homonymous downwards; the vertical distance increasing to the right lower part of the field. He was treated by mercury, iodide of potassium, and covering one eye by a dark glass. On May 28th, single vision was obtained in the upper part of the field; only a vertical distance of 3 to 4 in the middle part. It was now possible to take off the dark glass from the left eye, and to correct the remaining diplopia by means of a pair of concavo-prismatic spectacles. As the diplopia showed a vertical distance of about 3 degrees, and as a prism of 3 degrees (angle) gives a deflection of 1½ degrees, it was necessary to choose two prisms, each of 3 degrees; the angle of the prism before the right eye being turned downwards, and the other upwards. The prisms were combined with concave glasses of 12 inches, which the patient had usually previously worn. With these glasses he had single vision (including the lower part of the field, free use of the eyes in walking, etc.) After some weeks' single vision without prismatic glasses, the following table shows the results of the examinations :

	Feb. 13.	Feb. 20.	March 9.	April 13.	May 13.	May 28.
+20°, 0	-2°, +4°	-5°, +4½°	-4°, +6°	+1½°, +4°	0, +5°	-1°, +4°
+0, 0	-2°, +3°	-4½°, +3½°	-4°, +5°	-1½°, +4°	-½°, +5°	0, +3½°
-20°, 0	-2°, +2°	-5°, +1°	-4°, +4°	-1°, +3°	-½°, +4°	0, +3°
0, +XX	-6°, +2°	-6°, +1°	-5°, +4°	-3½°, +3°	-½°, +3°	0
0, -XX	+1°, +2°	+0°, +1°	+½°, +3°	+3½°, +4°	+3°, +4°	+2°, +4°
+20°, +XX	-5°, +3°	-5°, +1°	-3½°, +3½°	-3°, +1°	0, -3°	0
+20°, -XX	0, +4°	0, +3°	+½°, +5°	+3°, +4°	+2°, +5°	+3°, +5°
-20°, +XX	-5°, +1°	-7°, +2°	-6°, +4°	-4°, +4°	-1°, +4°	-½°, +3°
-20°, -XX	+2°, 0	0, +1°	0, -1°	—	+2°, +4°	+2°, +4°

CHART FOR MEASURING THE FIELD OF VISION.*

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THE medical aspect of ophthalmology has so rapidly developed during the last few years, especially in relation to cerebral diseases, that it is now deemed necessary to accurately test the field of vision in numerous cases where that course would not formerly have been adopted. In order to facilitate this process, and to enable clinical records to be taken with ease and accuracy, I have introduced a chart sixty centimetres square, which is divided into small squares of five centimetres each, a portion of these being tinted a pale grey colour. It is intended that each eye should be tested separately, at a distance of thirty centimetres from the chart, the patient being directed to keep the eye and the attention fixed upon a central spot coloured black, and one centimetre in diameter. From the latter, fine circles radiate with regularity, being separated from each other by a distance of two and a half degrees. The person who makes the examination is provided with a small metal pointer, the apex of which is precisely similar in size and colour to the central spot on the chart. This pointer should be placed upon the extreme margin of the chart, and slowly directed towards the centre till it is brought within the patient's range of vision. This should be done vertically, horizontally, and obliquely in each quarter of the chart, and the field should be carefully noted upon a smaller but similar chart, of which a good supply must be kept, so that one may be devoted to each patient. An accurate map of each individual field can thus be obtained, which should be retested at subsequent visits, when the slightest loss or gain in any direction will be at once noted. The chief merit of this method is its simplicity, so that a student can easily accomplish with it a considerable amount of useful and accurate work; and the reports which I have already received from several of my colleagues who hold ophthalmic appointments in large metropolitan hospitals, lead me to hope that clinical work may, in this direction, be much facilitated. It is not pretended that this chart can compete, in point of delicacy or range, with any of the admirable metal perimeters which have already been introduced, since these latter must of necessity include the extreme circumference of each field which cannot be gauged upon any flat surface; but perimeters are both cumbersome and costly, and, as this chart will be found sufficient for all practical purposes, I trust that it may meet a want which was, I think, very generally felt.

* The charts are published by Pickard and Curry, 195, Grinstead Street, W.