LOCALIZATION ON THE FUNDUS;
CONTRIBUTIONS ON MERIDIAN FAULTS;
A NEW LOCALIZING PERIMETER

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IN the treatment of detachment of the retina, the operation of Gonin (hole closing method) has opened a new era. Subsequently two other variations of his method (chemical-caustic and diathermic) have been developed. For each of these three methods the localization of the hole in the retina is of the utmost importance.

In most cases of detachment we find one or more holes in the retina. According to Gonin these holes play a decided rôle in the origin of the detachment. According to this supposition, if we can succeed in occluding these holes, the disease will be healed and the retina reattached. The occlusion of the hole is caused by means of a thermocautery, after the position of the hole has been determined. As we see it, an important feature of the operation—apart from the technique—is the localization. This consists of two parts: *viz.* the localization of the pathological changes of the fundus, the tear in the retina; and further, the marking of this retinal tear on the outer surface of the sclera at the point where the operation must be performed.

The determination of the spot on the globe demands two data, the meridian and the latitude. We determine the meridian by estimation according to the numbering of a watch and mark it on the limbus at the point opposite the tear. The determination of the latitude is made as follows: we take the most peripheral part of the fundus visible by ophthalmoscopy on the fully dilated pupil for the ora serrata and from this point we measure the distance between retinal tear and ora serrata in disc diameters. We regard the distance of the ora serrata from the limbus as 8 mm. and to this we add the measurement of the disc diameters, 1 disc diameter = 1.5 mm., which we transfer by means of dividers to the sclera.

The method based upon estimation is simple for the experienced, but where the necessary experience is wanting, the estimation very often gives incorrect results. In cases in which the estimation was right, but the result was not controlled by means of other methods, the surgeon does not have the feeling of certainty which the use of these other methods would have supplied.

In some essential points the localization on the perimeter is similar to the above mentioned method. In this case we also determine the meridian and the latitude, with the difference, that in

this method the distance is not *estimated* from the ora serrata, but *measured* on the perimeter. In this case, the meridian is determined by the angle which the plane of the perimeter arc forms with the horizontal, and the latitude by the angle which is formed by the line in which the ophthalmoscopic examination takes place and the line of sight of the eye to be examined. The size of the angle found on the perimeter we transfer to the eye to be operated upon in the following manner. In the determination of the latitude we must know what distance on the eye corresponds to the value of the angle read on the perimeter. Concerning this we find numerous data in the literature. Table I shows the chord distances in millimetres, measured from the limbus, which correspond to the angles on the perimeter arc.

TABLE I (according to Weve).

The chord-distances from the limbus (in mms.) referring to the angle values of perimeter arc.

Angle	Donders	Druault	Hallide	Colen-brander	Weve	Phantom eye
90°	8'0		7'8	7'25		7'0
80°	9'4	9'7	9'5	9'15	8'5	8'75
70°	11'4		11'4	11'5	10'5	11'0
60°	13'35	13'4	13'4	13'2	12'75	13'0
50°	15'5		15'2	15'4	14'5	15'0
40°	17'0	17'2	16'8	17'4		17'0
30°			18'3	19'15		19'0
20°		20'4	19'5	20'75		21'0
10°			20'6	23'1		

Some of the authors found their data in an empiric manner; they examined exophthalmic patients or newly removed eyeballs; while others determined geometrically the length of the chords according to the corresponding latitude angle measured on the perimeter arc. As we see by the table, the measurements and reckonings give almost an identical result. By means of the table we can, therefore, find in a simple manner the value of the angles of latitude measured in millimetres from the limbus.

The transfer of the meridian to the eye to be operated upon is theoretically easy. We mark two opposite points on the limbus on the horizontal diameter, and we measure or estimate the operating meridian with regard to the horizontal one. Before reviewing the methods based upon the perimeter we shall refer shortly to the difficulties of the determination of the meridian and the rôle which meridian mistakes play.

In the literature many authors desire the most exact determination possible of the meridian, but there are some who pay less attention to the matter.

According to Clausen “. . . für den Erfolg der Ignipunktur ist die genaue Deckung des Lokalisationsmeridians mit dem Netzhauttriss wichtiger als ein kleiner Irrtum in der Bogenlänge.” In opposition to that Colenbrander says: “Das Bestimmen des Meridians macht keine Schwierigkeiten. Dazu sind keine Berechnungen nötig. Eine gewissenhafte *Abschätzung** gibt hier die besten Resultate . . .” Some authors particularly emphasize the fact that the fault, caused by the mistaken determination of the meridian is greater the more distant the place to be operated upon is from the limbus. *E.g.*, Weve writes “. . . bei weit vom Limbus entfernten Rissen ein kleiner Fehler in der Meridianbestimmung üble Folgen haben kann.” We might conclude that faults in connection with determinations nearer the limbus play a less important rôle.

We have not found any statistical data covering this matter. The general view is that smaller faults in localization do not count, because the area of cauterization is so large that the tear falls within its radius. As this question has not been settled we made reckonings in order to determine how exactly we must mark the spot of cauterization, *i.e.*, how great exactness a successful Gonin operation requires. The essential part of the question is: what errors might be caused by faults in determination of the meridian, or by its transfer to the eyeball, and whether the errors caused by faulty meridians are greater than the area of cauterization. The question is, therefore, in case the determination of latitude is exact, what degree of meridian fault might cause an unsuccessful operation?

Those determinations which are based upon estimation, determine the meridian in such a manner that the position of the tear is referred to the edge of the pupil or to the limbus, which are viewed as the face of a watch. The face of a watch being divided into 12 parts, each hour represents 30°. As the size of an angle is the more difficult to estimate the shorter are the angle sides, naturally in such a small circle as that of the pupil or of the limbus we can easily make mistakes. The determination of the meridian on the perimeter has the advantage that it takes place in smaller units and so decreases the possibility of error.

The transfer of the meridian to the eye to be operated upon is very important. Here any mistake concerning the meridian becomes greater the nearer it is to the equator. Before and behind the equator the meridian faults are less, although the differences of

* The *italics* are mine.

values where the operation mostly takes place are scarcely to be taken into consideration. The most important place, from the operation view point, is that between the ora serrata and equator, this being the place where most retinal tears occur. Behind the equator only the first 6 mm. are to be considered, as so few operations are performed on the posterior pole, that no regard will be paid to this point in the following remarks.

We have determined the deviations caused by faulty meridians at 10° and 15° . Ten degrees are equal to one-third of an hour on the face of a watch, and 15° to one-half. If we err in determining the meridian by 10° , the difference from the ora serrata to the equator is equal to 1.88 – 2.09 mm., and at 15° 2.82 – 3.13 mm. In other words we make a deviation of about 2 mm. by an error of 10° or 3 mm. by 15° .

The reckonings were calculated on an eyeball, the corneal diameter of which was assumed to be 12 mm., the radius of the sclera was assumed to be 12 mm. The difference between the radius of the anterior and posterior parts of the globe is negligible in determining meridian faults. The problem, therefore, is that of constructing or reckoning that part, 10° or 15° , of latitude which corresponds to the chord's length. The corneal diameter d , and scleral radius r , and the chord b , are known. The angle a can be determined (Fig. 1).

FIG. 1.

$$\sin a = \frac{d/2}{r} \quad \dots \quad \dots \quad \dots \quad 1$$

The angle β corresponding with the tendon b is equal to

$$\sin \beta/2 = \frac{b/2}{r} \quad \dots \quad \dots \quad \dots \quad 2$$

The radius of latitude circle corresponding to the chord is equal

$$x = r \cdot \sin (a + \beta) \quad \dots \quad \dots \quad \dots \quad 3$$

The arc of 10° or 15° of the circumference of the circle,

$$\text{radius } x = \frac{2r\pi}{36}; \frac{2r\pi}{24} \quad \dots \quad \dots \quad 4$$

shows the corresponding meridian faults.

Fig. 2 gives a graphical explanation.

FIG. 2.

In Table II the values are given as far as the equator. The same values hold good for the 6 mm. distance behind the equator, but in an inverted series, *i.e.*, the greater the distance therefrom, the fewer the meridian faults.

TABLE II.

Chord-distance	X	meridian fault	
		10°	15°
7 mm.	10'78 mm.	1'88 mm.	2'82 mm.
8 "	11'20 "	1'95 "	2'92 "
9 "	11'54 "	2'01 "	3'02 "
10 "	11'79 "	2'06 "	3'08 "
11 "	11'945 "	2'08 "	3'12 "
12 "	12'0 "	2'09 "	3'13 "

Gonin's operation by cauterization causes the edges of the retinal tear to stick to the choroid by a process of seclusion by means of an adhesive inflammation. (Fisher.) Therefore the greatest success for the operation is assured if the cauterization exactly finds the retinal tear. It is advisable to cauterize both edges of the larger holes. In Luntz's experimental investigations it is to be seen that the area of cauterization is about 3.5 mm. in diameter, *i.e.*, a maximum of 2 mm. in radius. This means that in cases of 10° meridian fault it is probable that the tear does not fall into the area of cauterization, and in cases of 15° meridian fault—where its value is 3 mm.—the area of the cauterization does not even touch the retinal tear.

In reckoning the effect of meridian faults it is to be seen, that the exact determination of the meridian plays an important rôle in the success of the Gonin operation and relatively a small fault in meridian, one-half or one-third hour, makes the success of the operation doubtful.

In transferring the localizing meridian to the globe, *i.e.*, the determination of the operating meridian, it is most important to *measure* it, because otherwise, *e.g.*, by *estimation*, it would be impossible to transfer properly the *exactly determined* meridian to the globe. The method proposed by Lindner for transferring the meridian by means of a goniometer is exact, though a little complicated. Later on we propose a method of projecting the meridian directly on to the eyeball on which we can immediately mark it and thus prevent the sources of error caused by the transfer. From the above remarks, the importance of exact localization is evident. Let us see how far the methods based upon the perimeter satisfy these demands.

The regular perimeter is difficult to use in localization. (1.) Because the supporting arm and its base hinder the ophthalmoscopic examination between 4.30 and 7.30. (2.) We can only perform ophthalmoscopic examination at the edge of the perimeter arc and thus the meridian found is inaccurate, because the scale on the perimeter refers to the centre of the arc. As the retinal tear often occurs in the upper part of the fundus an ophthalmoscopic examination from below is necessary. The following methods are intended to prevent such mistakes.

Lindner's apparatus consists of a perimeter arc mounted on a Gullstrand ophthalmoscope. The examination takes place as follows: The patient looks at the lamp fastened to the perimeter arc and the movable lamp is put in such a position as to bring the retinal tear into the visual field of the ophthalmoscope. Here also the two above-mentioned angles, the meridian and the latitude, have to be determined. According to Lindner, the transfer of the meridian to the eyeball is performed by sewing a small metal

circle—which is divided into 360° —to the globe and the meridian is shown by a hand fixed to the centre of that circle. The use of Lindner's apparatus is limited because some parts of Gullstrand's ophthalmoscope come into collision with it and in these parts the apparatus cannot be used. Another disadvantage of the method is that during the determination, the eye moves and principally in localization, on the extreme periphery the rotation of the eye makes accurate determination of the angle values impossible.

Guist's method may be classed in the same group. Here we determine the two angles above mentioned. The patient constantly looks at one point in the centre of the perimeter arc. The spot on the fundus to be localized we search for by means of a movable ophthalmoscope mounted on the perimeter arc. In comparison with Lindner's method that of Guist has the advantage of determining every spot on the fundus, the perimeter arc being capable of use in ophthalmoscopic examination in every position. As the ophthalmoscopic examination takes place in the axis of the perimeter arc, the finding of the meridian also is exact. Guist's method is reliable but the determination is difficult owing to the cumbersome apparatus.

The apparatus recommended by Weve is a perimeter arc moving on a vertical axis. The determination takes place on a recumbent patient in such a manner that while the patient looks at a small lamp in the centre of the perimeter arc, we first seek the tear indirectly by means of an electric ophthalmoscope on the perimeter arc, afterwards taking away the condenser and looking through the pupil into the eye. The tear is shown by a bright red reflex. The position of the ophthalmoscope then corresponds to the projection of the tear. Now we place a glass eye on the same spot as the eye of the patient previously was. The glass eye we illuminate by aid of the ophthalmoscope from the same spot on the perimeter arc and then find the image of the ophthalmoscopic lamp on the frosted wall of the glass eye, which corresponds to the tear in the patient's fundus which without any further reckoning we may immediately measure.

Some details of determination, as well as the transfer of results on the eye to be operated upon, may easily become sources of error. The substitution, *i.e.*, the placing of the glass eye in the position occupied by the patient's eye, demands special attention. Further delicate points are the measurement of the spot to be localized, which is performed with the aid of a pair of dividers specially designed for the purpose, and the transfer of the result to the patient's eye. There are therefore three such aspects in which mistakes must not occur, *i.e.*, there is a possibility of three sources of error.

F. P. Fischer's localizing ophthalmoscope is not essentially

different from those already mentioned. A Gullstrand hand ophthalmoscope is mounted on the perimeter arc. Great attention must be paid to the adjustment of the apparatus and to the placing of the eye in the curvature centre of the perimeter arc. The determination takes place by means of indirect ophthalmoscopic examination and it refers neither to the nodal points of the globe, (Lindner, Guist,) nor to the plane of the pupil, (Weve,) but to the vertex of the cornea. The results gained are drawn in natural size on a paper and that is placed on the globe to be operated upon, where the point sought for may be immediately found.

Fischer's method cannot be used in some cases and particularly in cases of most peripheral tears because it can be employed only up to 65° . The transfer of the results to the patient's eye takes place essentially in the same manner as Lindner's with the difference that Fischer places the *flat* paper on the *curved* surface of the globe, a method which may give rise to errors. The advantage of the method is exact determination. Fischer's apparatus, from a technical point of view, has remained behind the apparatus already known. (Guist, Weve.) The merit of Fischer's contribution is that he has shown the importance of the fact that the localization must refer to the vertex of the cornea.

Below we shall draw attention to a localizing perimeter which has been employed in our clinic for about three years. In comparison with already described perimeters, although it shows some points of similarity, the simplicity of its treatment, the certainty of its results and finally because of the possibility of direct transfer of the results obtained to the eye, we find it worth while to publish. The model of the apparatus was demonstrated before the *Hungarian Ophthalmological Society* at its annual meeting, 1931.

As we have already mentioned, we have need of such apparatus as will be useful at every point on the perimeter arc, *i.e.*, by which every point of the fundus may be determined. Further, it is necessary that the ophthalmoscopic examinations, take place in the central line of the perimeter arc, *i.e.*, that the meridian may be exactly found. The first condition is fulfilled by the fact that with aid of an articulation, the perimeter arc may be placed in any position so that the supporting arm does not hinder the ophthalmoscopic examination. The second condition is fulfilled by performing the examination in the central line of the perimeter arc.

The perimeter* is mounted on a heavy three-legged stand. (Figs. 3 and 4.) The rectangular arm supporting the perimeter arc can be raised or lowered by means of the cog-wheel. Mounted on the rectangular arm is a joint which enables the perimeter to be turned horizontally in the axis of the arm. This articulation ends in a

* Made by Theodore Hamblin, Ltd., 15, Wigmore Street, Cavendish Square, London, W.1

socket. The axis of the socket and that of the articulation form an angle of 90° . The socket resembles a drum, on the top of which an arc about 25 cm. in diameter is fixed. The perimeter arc is mounted in a rectangular position on the before-mentioned arc. The level of the upper edge of the perimeter arc cuts through the centre of the socket. By means of the joint and the drum-like socket the perimeter arc may be turned in any direction, *viz.*, by aid of its articulation the perimeter arc may be turned downwards (Fig. 4), so that we can examine patients in a recumbent position. The small arc placed within, makes it possible to examine at every point of the perimeter, as the size thereof makes it easy for the surgeon to put his head into it.

A small movable ring-like slide is placed on the 180° perimeter arc, exactly in its middle line and through this the ophthalmoscopic examination takes place. This slide exactly marks the place of the examination. In addition, there is a movable disc on the perimeter arc, which contains the indicators necessary to visual

FIG. 3.

FIG. 4.

field examination and also a small lamp. The disc can be moved to the centre of the arc and in this position the small lamp serves as a fixation point in localization.

We have proposed the following alterations in the model now in preparation (Fig. 5). A supplementary arm containing a removable condenser (*c*) on the perimeter arc is mounted in such a way that the optical centre of the condenser falls on the line connecting the turning point of the perimeter arc with its curvature centre (*o*). The condenser throws the image of the small lamp (*l*), which is placed in the turning point of the perimeter arc, on to the curvature centre, *i.e.*, on about 33 cm. This arrangement, which consists of condenser and fixing lamp, plays a double rôle: (1) by means of it we place the eye to be examined in the curvature centre; (2) we transfer the meridian found on to the globe.

The eye must be at the curvature centre of the perimeter arc, otherwise the determination of the angle values will be impossible. The placing of the eye in the curvature centre is assisted partly by means of the condenser, *i.e.*, the image of the fixing

lamp thrown by the condenser falls into the curvature centre. Therefore we must place the patient's eye so that the image of the fixing lamp falls exactly on the cornea. Because of reasons to be mentioned below, the filament of the fixing lamp is a single straight line, the image of which is distinct and the focusing is not difficult. In order to determine when the eye is in the desired position we make use of the finder (*f*) placed on the end of the perimeter arc, which is adjusted on the curvature centre. In this manner we place the eye in the right position by means of a line drawn from the turning point to the curvature centre (*l-o*) and one drawn from the finder to the other end of the perimeter arc (*f-o-e*), i.e., its diameter (*f-e*).

The above-mentioned condenser also plays a rôle in determination of the meridian. The straight filament of the fixing

FIG. 5.

lamp is in the level of the perimeter arc and thus follows its revolution, i.e., always marks the position of the perimeter arc in the localization of the meridian. The condenser projects the image of the filament on to the eye and the bright line of light touches the limbus at two opposite points. Therefore we have a means of projecting the meridian on to the eye at the moment of determination.

A plate covered with Stent's wax into which the patient bites, (Beissbrett), which can be raised or lowered at will, or a chin-rest, both of which are fixed to a turn stool, serve to keep the patient's head in the proper position. This attachment makes it possible to examine the patient in the most comfortable position. If the searched for place be in the upper part of the fundus, the raising of the perimeter arc and the biting arrangement makes the examination easier, just as it does in the lowering of the perimeter arc and the biting arrangement in the examination of the lower parts. By this means we can almost entirely avoid inconveniences in the examination.

The separation of the head fixing apparatus and of the perimeter arc we also find in Weve's and Fischer's method. But Weve can examine patients only in a recumbent position, and Fischer's head fixer is mounted on a table. Formerly we also

used the same method, *i.e.*, by placing the patient's head in the chin-rest of the slit-lamp. In our experience, the table between the patient and perimeter proved a hindrance. By mounting the head fixer on a turn stool, the apparatus became much easier to handle. Here we should like to remark that the stool fitted with the head fixer may also be employed in cases requiring Bjerrum's examination, ultra-violet irradiation, also red-free ophthalmoscopic examination, in a word, in all cases where the fixing of the eye is important.

The determination takes place as follows. In a previous examination of the eye we gain a certain knowledge of the fundus and then continue the examination with the aid of the perimeter. We place the patient's eye in the curvature centre of the perimeter arc. For this purpose we roughly measure about 33 cm. distance, the radius of the perimeter arc, with a ruler or thin lath. The more exact adjustment of the eye takes place according to the above mentioned method. Then the patient looks fixedly at the lamp at the turning point of the perimeter arc. The surgeon searches for the tear most expediently with an electric (self luminous) ophthalmoscope in an indirect manner. Then we take away the condenser and search for the tear with the ophthalmoscope. In most cases the tear is easily recognisable because the surrounding grey detached retina is very different from the red reflex of the tear. If the ophthalmoscopic examination is performed through the ring-like slide of the perimeter it makes the findings more exact.

In the first examinations we tried to make the determination by placing a movable arm on the perimeter arc which was parallel with its radius. On this arm a condenser and a crossed thread were mounted. Both were movable on the arm so that the common axis of the cross thread and condenser ran into the curvature centre. We were obliged to give up this method because the exactly regular formation of perimeter arc did not succeed and thus the common axis did not always point towards the curvature centre. Therefore we turned to the method in which a condenser was not used. In the examination we place the plane of the iris, *i.e.*, pupil in the curvature centre and having in view the short distance between the vertex of the cornea and the iris, we may say that the determination took place on the vertex corneae. (Weve.)

The angle found on the perimeter arc gives the latitude, and the position of the arc the meridian. As these two data locate any point of the fundus, the records of results of examinations made at different times become comparable.

From the point of view of operations, the transfer of the results to the globe is important. For this purpose we project the meridian in the before-mentioned manner on to the eye, and mark the two opposite points on the limbus with Indian ink or fluorescein. *Therefore the determination of the meridian, which according to the literature is difficult, is simplified as far as possible by the above-mentioned method.* The latitude reckoned in millimetres from the limbus we can read on the perimeter arc, as the chord distances corresponding to the angles are marked there.

In the former examination the patient looked fixedly at the lamp placed in the centre of the perimeter arc and the ophthalmoscopic examination took place on the arc. If now we draw the ring-like slide to the centre of the arc and the patient looks at the sliding

lamp while we examine the eye through the ring, we can control the results obtained. Here the determination is made as in Lindner's method. In this case the patient's line of sight and the line of ophthalmoscopic examination are changed, *i.e.*, the line of ophthalmoscopic examination comes into the centre of the arc and that of the patient's sight into the same latitude as that in which formerly the examination took place, but at a meridian-angle of 180° further. By this means the determination is not so exact, especially in the extreme positions of the eye, as when the eye is in a position of rest and looking straight in front, but the accuracy is quite sufficient if we use it to supplement data gained by means described above.

With this we have finished the localizing methods based upon the perimeter. Its employment in localization is important because the determination of the meridian and latitude takes place in smaller units and thus the possibility of error is lessened, we project the 12 mm. radius globe on to a 33 cm. radius perimeter and thus we make the determination as if under a magnifying glass.

Imre's method is to be noted separately as it stands between the methods of *estimation* and of *measure*. The meridian is estimated, and the latitude measured by a simple method. We sew a long silk thread into the limbus, at right angles to the meridian of the tear. One end of the silk is put through the hole of the ophthalmoscope and the other end is held by an assistant and serves as a fixation point for the patient's eye. The retinal tear we bring into the middle of the ophthalmoscopic field, and then measure the angle formed by the silk. The advantage of this method is that the determination can be made very quickly and that nothing is necessary except a goniometer.

The common feature of the methods hitherto described is that we obtained either by estimation or by measurement two data, *viz.*, the meridian and the distance from the limbus. By these two data any point on the fundus may be characterized. Majewski and Comberg have tried to localize the position of the tear by transillumination of the sclera. According to them if the light be placed behind the tear, and at the same time we perform a direct ophthalmoscopic examination, the tear in the retina will be shown by a bright spot. By this means the place of the tear answers to the position of the light on the sclera, and thus the place on which the operation is to be performed is immediately found. This method, which seems the simplest, is of no practical value because due to the opacity of the sclera the rays, which pass through it, are dispersed.

Summary

1. We have determined the amount of the deviation caused by faulty meridians with regard to the spot on which most Gonin operations are performed. These faults in cases of error of 10°

are about 2 mm. and in those of 15° are 3 mm. If determination of meridian takes place according to the face of the clock, 10° is equal to one-third, 15° to one-half of an hour. In determinations based on estimation such mistakes may easily occur, and in themselves may make the success of the operation doubtful.

2. The localization on the fundus can be most exactly made with the aid of a perimeter because we determine the meridian and latitude in smaller units and thus lessen the possibility of faults occurring.

3. Besides being easy to manipulate, the proposed localizing perimeter makes it possible to project the meridian on to the eye and thus we can avoid faults connected with the transfer.

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A CASE OF CONGENITAL CATARACT SHOWING UNUSUAL FEATURES

BY

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CAPE TOWN

A HEALTHY and well grown Swahili boy was brought to me from the Athlone School for coloured children. There was nystagmus, and a dense white opacity in each pupil which reduced his vision to mere light and dark.

The iris acted normally, but on dilating the pupils a very remarkable appearance presented itself which I have tried to depict. The drawing was difficult and tedious owing to the nystagmus, the nervousness of the patient, and my inability to speak his language. The lights and shadows are exaggerated by the brilliant light of the slit lamp, and I have taken some liberties with the irides as they were normal and not associated with the actual abnormalities.

In the centre in each eye was a very dense circle of capsular opacity, with a yellowish raised epicapsular spot, and several smaller specks, remains of lens matter. These were more numerous in the