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"The Operative Treatment of High Myopia."

The practical consideration of this important and highly interesting subject was revived by Fickala of Silva, ten years ago, since when this therapeutic measure has rapidly spread over the Continent of Europe, among its most ardent supporters being Schweigger of Berlin, Pflüger of Berne, Theodore Schroeder of Petersburg, Thun of Maairen, Vacher of Orleans, v. Hippiel Vossius, British ophthalmic surgeons, up till the last year entirely viewed the operation with distrust, but it is now steadily gaining ground.

I propose considering this subject under the following heads:

i. History and Bibliography.

ii. Disadvantages of High Myopia.

iii. Advantages of Aphakia.


v. Difference in Refraction produced by extraction of the Lens.

vi. Indications and Contra-indications.

vii. Should one or both eyes be operated upon?


ix. Dangers.

i. History and Bibliography.

Until recently, it was generally supposed that the first mention of this method of treating high Myopia was
made by Baur in 1817; but in a recent paper, Vacher states
that Dr. Bujaudeau wrote to him, saying, that in a work
by the abbé Bovonsecque, published in 1776, the fol-
lowing passage occurs: "Les myopes de 2 à 3 parsecs
de foyer sont les sujets bien malheureux, puisqu'il
se voient que personne ce qui est à leurs pieds;
ils sont par conséquent, peu propres au travail. C'est
pourquoi lorsqu'ils sont encore jeunes, on avise d'
extraire le cristallin, ce qui diminuera l'extension
de la comète et prendra l'image de objets plus sen-
sible. Cette opération ainsi que je l'ai annoncé dans
un ouvrage que j'ai donné en 1776, est moins re-
dommable que celle de la cataracte, parce que le
cristallin qui n'est pas altéré, dont la capsule est
ouverte, s'échappe plus aisément à l'ouverture de
la comète." In another part one reads, "La cataracte
n'est pas la seule cause qui puisse déterminer à
faire la section de la comète. Le parfait myope
est souvent dans ce cas, lorsqu'on prétend que le
prince de cette maladie consiste dans le trop
gras volume du corps lentiqueulaire. Alors j'ai sou-
vent vu pratiquer cette opération avec succès, parce
que tout cristallin, dans quelque état qu'il soit,
pour être extrait, et que de cette extraction le
parfait myope en reçoit une amélioration réelle,
These passages clearly show that the aphatic treatment of Myopia was well-known to the able Desmoulacque more than a hundred and twenty years ago. If Vacher remarks, it is strange that the passages above cited, should have passed unobserved till quite recently. He proposes that the excision of the lens for the relief of high Myopia should be called "Desmoulacque's Operation".

Fukula points out that A. G. Richter, a professor at Gottingen, in a work under the title of "Anfangsgründe der Kunst der Wundargenist" published at Vienna in 1790, not only spoke of the different causes of Myopia, eg, increased length of the Optic axis, too great curvature of the Cornea or abnormal concavity of the crystalline lens; but went on to say "Das einzige Mittel dieser Art wäre die Anzeigung oder Niederdrückung der Linse, ein Mittel, das auch selbst im Falle der stärksten Kügigkeit zu durchaus wenig nützen, schwer anwendbar ist."

The next person to suggest the removal of the lens was Beer, in his work published in 1817, though he did not carry out the operation practically.

In support of it, he writes, "Dafur möchte schon der Erfolg der StarausschäNNung laut sprechen, welche
von der Entstehung des Staeres in einem sehr hohen Grade bangezichtlich waren, denn kein anderer auch noch so glücklich operierter Staerlinder erfuhren sich eines so trefflichen Geschehens, von dem der Bangezichtige niemals einen Begriff gehabt hat.

Weller of Dresden, quoted by Vacher (loc. cit.) in a work on diseases of the eye, translated into French by Rettel in 1852, said: "Pour remedier au plus haut degre de myopie inveter, voisins de la cecité, on a propose d'extraire le cristallin apres d'obtenir une precision radicale. Ce traitement est fondé sur ce qu'on eloigne, par cette operation, l'un des milieux de l'oeil qui est done de la plus grande force de refraction; et sur ce que l'on sait par experience, que les individus qui etoient myopes avant de subir l'operation de la cataracte par extraction, ont eu par la suite une tres bonne vue.

At the Heidelberg Ophthalmological Congress, held in 1858, Moore Fisher again drew attention to this subject, but were met with overwhelming opposition from Graefe & Donders. Von Graefes contention was that progressive Myopia was the result of progressive degeneration at the hinder pole of the eye (sclero-chorioiditis bulbosa).
and be could not see in what way the removal of the lens could prevent the advance of those changes. Therefore of the Myopia. This being the case, and the result of removing a transparent lens from a highly myopic eye being uncertain, he was strongly opposed to the operation. Donders, while admitting that vision would be somewhat improved on account of the enlarged retinal images, believed that this would be more than counterbalanced by the Myopia losing his accommodative power. In the English translation of Donders' classical work on the anomalies of refraction and accommodation, p. 416, we read "But I need not say that such a momentous undertaking (removal of the lens), doubly dangerous where a myopic eye or a transparent lens are concerned, would not merely, even in the most favorable case, any real advantage is to be expected, would exhibit "culpable rashness." Not only would the Phthisema posterior continue equally threatening, but we should also have sacrificed the accommodation — an advantage which that of somewhat larger images than could be obtainable by neutralizing glasses, could by no means counterbalance."

In the face of the opposition of these two supreme ophthalmological authorities, the operation naturally fell
to the ground, more especially as a case, from which Mooren, shortly afterwards, extricated the lens, lost his eye from hyperplasia. This is not surprising when we think that at that time (1863) the loss of sight after cataract operations, amounted to 23%. Had the loss only been, as it now is, about 1%, Mooren would most probably have repeated the operation and been able to show its utility.

Duell in a paper on diseases of the eye, published at Paris 1862, spoke of extraction of the Crystalline Lens as a method of treating high Myopia.

Maucleret confirmed the statement made byBeer in 1897 that cataractous myopes are more pleased after extraction of the lens, than patients who were previously emmetropic. Thus he says, "The operation for cataract, in highly myopic persons, gives us the most thankful patients; for, if their acuity of vision was formerly defective, they are delighted to find their sight better in their old age, than it ever was in their younger years."

The recent publications on the subject were almost simultaneous, and are very interesting, in that they mark the renaissance of this method of treatment, and its being placed on a practical and probably permanent basis.

On May 7th 1890, at the Soc. Francaise d'Ophthalmolog., Vachet gave an account of two cases, in which he had extrac
the crystalline lens for high myopia, the first having been operated upon in April 1887, and the second in October. The other publication was by Feickel, also in 1890. To him belongs the credit of first carrying out the operative treatment of myopia by aphakia, systematically. This first case was operated upon in April 1887, exactly two years before Vacher's first case. It must have required great courage to have given him courage to operate on a sedentary patient, in the face of the dictum of Graefe and Bondesen, and against the advice of Allot, whom he had previously asked for an opinion on this matter. In his first paper on the subject in Graefe's Archiv, he referred to the trouble myopes were afflicted with on account of their defective vision, when, in the higher degrees, they were unable to wear correcting glasses. He considered cases of unilateral myopia as especially suitable for operative treatment. He then gave an account of 19 cases, in which he had carried it out in myopes up to age of 130 upwards, and in all of which he obtained considerable improvement of vision.

In March 1891, Schroeder published two cases, on which he had operated with good results.

In November 1891, Vacher made a communication on this subject, to the Société d'Ophtalmologie of Paris, where he was strongly opposed by de Wecker, Paris, Gab-
gowski, Parent, others, who maintained that the operation could not arrest the progress of the myopia and that it predisposed to detachment of retina. He was supported by Aladie & Meyer.

In 1892, articles by Colwell and Martin appeared in the "Revue d'ophthalmol." on this question, and in this same year it was introduced for discussion at the Heidelberg Ophthalmological Congress by Schweiger and Pfliiger. The former said he had operated upon 6 cases only in cases of at least 16 D. The procedure adopted was the same as in operating on a soft cataract; first through division, and then, when the swollen lens matter gave rise to irritation, extraction. He disapproved of iridectomy as "utterly superfluous." The criticism for extracting the lens matter was made below, 2 or 3 mm. from the corneal margin. He had operated upon four children of from 10 to 14 years of age & a woman of 34. All did well.

In estimating the acuity of vision in high myopia, he preferred to have the eye put in frame, so that the patient could hold it in whatever position he liked best. He advised operation on one eye only, so that the aphakic eye could afterwards be used for distant & the myopic eye for near vision. Pfliiger considered the doubt as to the propriety of the operation,
which had been raised on several sides which were still held as "gegenstandlos". "Whoever has carried out this operation a number of times, and has seen the more-than-hoped-for result and the thankfulness of the patients, is henceforth without doubt." He had hitherto operated upon 15 cases, mostly between the ages of 15 and 25 years. Two patients were over 30 years old. He confined the statements made by Fukada, in regard to acuity of vision's refraction. Vision improved two to fourfold, as the result of the operation. This was due, in his opinion, to shifting forward of the nodal point, with corresponding enlargement of the Retinal Images. He considered high degree of Choroiditis (especially where the macular region is affected), and old age as contra-indications. His method of operation was thorough dissection, followed by extraction of the lens matter some days subsequently. He had only performed iridectomy in the two cases, who were over 30 years of age. He disagreed with Fukada's explanation of the great difference between the refraction of a much elongated eye, before and after Aphakia, viz. that the lens had an increased refractive power, as compared with the lens of an Emmetropic eye. He explained the difference by the distance at which the ca-
recting lens was held from the Cornea, when estimating the refraction, which made the Myopia appear much more considerable than it really was, whilst the small amount of myopia or Hypermetropia left in Aphakia did not suffer much apparent diminution, whether the glass be held close to the Cornea or at the usual distance (13 to 15 mm).

In the discussion that followed, Handoll opposed the operation on the ground that its aim was to reduce the Refraction of the eye, but this, in the greater number of cases, was the least disadvantage of a highly Myopic eye, and could be corrected by glasses. The condition at the back of the eye were left untouched, and, in addition, there was the danger of intravascular hemorrhage or Retinal detachment following the operation. Wichterlein gave an account of the cases he had treated, and said he had for some time plucked up courage to remove the lens in highly Myopic patients, between 40 and 50 years of age. Michel agreed with Handoll's views, and thought the operation was a mutilation of the eye, saying it reminded him of rhinologists making a clean sweep of the structures in the nasal passages, for the cure of snuff taking.

Thier said he had done the operation on both eyes in three patients, and on one eye only in three others,
all with good results.

Saneho, tned all his fears on the ciliary processes. According to him, the ciliary glands could not properly
from their secretion into the interior of the eye, without
the action of the ciliary muscle, the function of which
is removed when the lens is extracted. Consequently,
the fall of tension, produced by removal of the lens, is
not so rapidly or completely overcome, as it should be,
by an increased flow of fluid into the eye. In conse-
quence, he thought there would be great tendency to
the retina becoming detached. This rather far-
fetched theory has not been shown to have any
grounds in the cases, numbering over 1000, which
have, up to the present, been operated upon.

Ficht Middendorff spoke in support of the operation,
the latter referring to 8 cases which had successfully
undergone it, in Russia. He operated upon one eye
only, so that one eye might be used for distant,
and the other for near vision.

Valade made mention of two cases in which he had
extracted the transparent lens for high myopia.
One gave a good result, but, in the other, a total
detachment of retina occurred two months after
the operation.

Schweigger replied to Landolt that the operation
should only be carried out in those cases, where the requisite strong convergent glasses could not be borne, as is the case in nearly all cases of high myopia. The other objections, which had been brought forward, would apply equally well against operating on congenital or senile cataracts.

Zinger pointed out that cases with 15 to 15 D of myopia and upwards could not wear glasses that gave a desirable working distance, since, in consequence of the diminution in the size of the retinal images, the object was brought nearer and an injurious strain on the accommodation resulted. Aphakia rendered such pupils fit for work. He considered loss of accommodation must be viewed as advantageous, since the choroid is placed in a state of rest, which must be a great prophylactic against degenerative or inflammatory changes occurring in it, or becoming worse.

I have gone into the detail of this meeting somewhat at length, because it is the first time that the authorities on this subject had an opportunity of meeting together and discussing it, and comparing their views in regard to the necessity of the operation, its method of performance, its indications and other points. The record of this meeting shows that a
considerable number of leading Continental opticians had already in 1892 performed the operation, with almost uniform success. The operation relied almost entirely on theoretical objections, whilst everyone who had tried it, supported it.

In the same year, we find publications on this subject by Fukala, Schrögl, and Valucl.

At the next year's meeting at Heidelberg (1893), the "Treatment of Myopia by Aphakia" again took an important place in the discussions and the remarks of the various speakers showed that this therapeutic measure was rapidly coming to the front. The subject was introduced by its pioneer, Herr Fukala of Berlin, under the title of "Mehrrjährige Erfahrungen an wegen hoher Myopie extrahirten Augen".

He began by dwelling on the incapacity of myopes for most occupations, and their great desire to be able to see at a distance. Correcting glasses of 15 D, he said, were almost never tolerated, on account of the great diminution of the retinal images and apparent removal of objects.

He cited two cases in which he had dissected the lens for high myopia, once in a governess, aged 26 years, who had 74 D, which was progressing and rendered her unable to continue her work; after dissection only 5.5 D remained, she could read with ease and wear correcting glasses. The other case was a
12-year-old boy with +15 D; his parents could think of no occupation for which he would be fit; but, when aphakic, he was emmetropic, loved gardening and with +4 D could read ordinary print fluently.

Subsequently, one went on to consider the indications and contraindications of the operation, e.g., the age of the patient and the amount of myopia present, and also the question as to whether one or both eyes should be operated upon. He considered myopia of 15 D gives the most perfect after-result, since, after removal of the lens, the focal point is usually situated at from 20 to 30 cm. distance, so that the patient can work exactly without a glass, and can either wear a weak glass for distance, or do without one altogether, since, being used to dim vision, they do not notice much the slight circles of diffusion produced by the imperfect focusing of objects on the retina. He then mentioned the improved vision, which he had observed to follow the operation, which had been confirmed by Schweigger, Pflüger, v. Schroeder, Thier and others. He never made the important statement, that, in patients, who he had had the opportunity of observing for 5, 10 or 15 years after the operation, the refraction of the eyes had remained stationary. This, if future observations should confirm it, may
he looked upon as one of the greatest advantages of this method of treatment. Its explanation will be dealt with under another heading. He finished his discourse by pointing out the great difference in the amount of the refraction produced in a highly myopic eye by Aphakia, and this he ascribed to an increased refractive power of the Lens.

In the discussion which followed, Whippel, Seixrist (Zürich), and Thiel spoke decidedly in favour of the operation. Value said the case he had referred to at the last Congress, in which the Retina of one eye had become detached, was in danger of losing the other eye, after remaining well for two years, for the same cause.

In this year, papers on this subject were published by Schweigger, Thier, Fergus (Glasgow).

In 1894, it was once more keenly discussed at the International Ophthalmological Congress, held in Edinburgh, when it was introduced in two valuable papers by Thiel and Fukuoka respectively. This drew attention to the fact that a person previously highly myopic has, when Aphakia, a considerable range of vision (pseudo-accommodation), much more extensive than he could have had when the lens was still in site. Fukuoka stated that he had been
treating high myopia by operation for seven years. He referred to his first publication on the subject, in Graefe's Archiv, in 1890, and his further remarks at the Heidelberg Congress in 1893. He had given up directotomy in these cases, except when the patient was over 30 years of age. In his opinion, dissection followed by subsequent extraction was to be preferred to direct extraction of the transparent lens, to which he ascribed the bad results obtained by Moore, Reiz, Korzus, and Vandeke (already referred to).

Up to the time of the Edinburgh Congress, Fukale had been able to collect 197 published cases, in which the lens had been removed for high myopia, viz.

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<tr>
<th>Author</th>
<th>Cases</th>
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<tr>
<td>Schweijzer</td>
<td>36</td>
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<td>Plüger</td>
<td>40</td>
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<td>v. Tippel</td>
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<td>Theer</td>
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<td>v. Schroder</td>
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<td>Moore</td>
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<td>Hornbrunn</td>
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<td>Fukale</td>
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<td>Tyskolanowski</td>
<td>4</td>
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<tr>
<td><strong>Total</strong></td>
<td><strong>197</strong></td>
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In the account of this meeting, which appeared in the Ophthalmic Review, April 1895, Priestly Smith
added 23 more cases, viz. Meigiani 3 & Ferguson, 9, reported at the Congress by these oculists, & 11 by Ferguson of Macayck. This made the total up to date 220.

In the subsequent discussion, Meigiani & Ferguson (both of Glasgow), & Pfüger related their experience. The first named had done 3 cases — two did well, the third suffered from detachment of retina within three months after the operation. The other two surgeons had not had any mishaps of moment.

Schmidt-Beißler did not hint to the removal of the lens prevented subsequent progression of the Myopia.

Papers were published in this year by Theni, Fuchsa, v. Schröda, Hori, who gave the details of the first 15 cases operated on by Schweiger, v. Steppel, v. Pfüger.

In 1893, this subject again came up for discussion at the Heidelberg Congress, being introduced by v. Steppel & Sattler. A long interesting article by Dr. A. Vossius, of Giessen, appeared in March 1893, in "Beiträge zur Augenheilkunde", whilst others were published by Schanz, (of Dresden), Perger, (of Breslau), Eppen, & Greff. A paper was read before the Optical Society of the United Kingdom, in the same year, by Charles Maug, under the title of "The Extraction of the Lens (transparent) in high Myopia."

It seems remarkable that so little was apparently known...
by British realists, of this subject, at such a late period as this, when the operator had almost entirely lost its novelty on the Continent. Wray had investigated the records of 25,000 myopes, of whom 123 had myopia of over 10 D, i.e. cases in which the question of operation might arise. "Of 246 eyes, representing 123 patients, 58 eyes (including 3 with detached retina) had V < 3/6, so that in all 55 out of 58 eyes were lost from change in the retina or choroid." From these statistics, he infers that "retinal detachment is less to be feared than the changes in the retina or choroid (3 of the former to 55 of the latter) and that it is not necessary to look upon every myope of 12 D upwards as hopelessly drifting towards detached retina or visual insufficiency from retino-choroidal changes, and especially seeing that the patients on whom these statistics are based were mostly very poor and many had chosen unsuitable occupations." Wray then mentions the cases of detachment of retina following the removal of the lens in high myopia, which had hitherto been published, but the object of showing that this misfortune was of anything more frequent after this operation. He thought that previous records tended to the conclusion that it exerted no influence on the progress of the changes.
at the post. for le of the eye. After referring to the possibility of improving the vision by Fukala's operation, and the brilliant results recorded by Pflüger, Schinner, Thiels, Heppel & Fukala, Dray concluded by asking the Society's advice in regard to a case with M. W. & V.  

\[ V = \frac{6}{36} \]

Mr. Spencer Watson in reply, began with a most remarkable sentence. In the 'Transactions' of the Society, he reported to have said "it was quite a new subject to him," and this eight years after Fukala's first operation and five years after his first publications! - "He did not know of anyone in this country, who had actually done the lens for high hyperopia", and yet at the Edinburgh Congress 1894, Agnes They have reported twelve cases in which they had done it. "Personally, he would hesitate very much before performing such an operation. It was not at all likely to attain the object they had in view, which the author suggested it might be likely to effect." Upon what grounds did he make this statement? - He did not use any theoretical reason; as far as practical experience went, he had had none. Of what value was it to make such an operation, when it had already been shown by, I think, I may say, very evident, who had performed the operation, that it did not
The object they had in view, viz., improvement of vision or capacity for work. Further, Spencer Watson quoted a case, which hardly supported his remarks, in which he had extracted a cataractous lens from a highly myopic eye, with a good result.

Lang mentioned a case in which he had removed the lens by dissection, but the Retina became detached some afterwards, and after some months, the same thing occurred in the other eye. He also had a second case, in which suppurative inflammation and loss of sight followed a needleing of the joint capsule.

A. Marshall had seen two patients operated upon with unsatisfactory results. In one case, detachment of Retina occurred, in the other suppurative followed a needleing.

G. Lindsay Johnson reported a case of M. of 18 in 1900, in which he removed the lens by dissection with good result, V improving from \( \frac{20}{100} \) to \( \frac{20}{50} \) in one eye \( \frac{20}{100} \) to \( \frac{20}{40} \) in the other.

At the annual meeting of the British Medical Association, held at Carlisle in July 1896, the Operative Treatment of high Myopia was introduced for discussion by J.B. Sandford of St. Thomas's Hospital, and F.R. Cross of Bristol. The former had not had much experience of this treatment, but gave the results & conclusions.
which had been arrived at by Continental authorities, under the following heads (1) The degree of myopia necessary to make the operation beneficial (2) The age at which the operation may be undertaken (3) Technique (4) Results of this method of treatment (a) as to refraction and visual acuity (b) as to the future of the eyes operated upon.

Dr. Cross began his paper by giving a table of the cases of Myopia he had treated, which showed that the average amount of Vision, obtainable by the aid of glasses, progressively diminished with the degree of Myopia, so that Myopia of 17 to 20 D could, on the average, only obtain 6 to 7 normal Vision. The defective vision depends "partly upon Amblyopia and partly upon the aberration of light associated with a strong Spectacle Law." Cross then gave a table of 9 cases operated upon for Myopia by him. He certainly cannot be accused of having selected favourable cases for the operation. He said "I give details of 9 cases, 6 of which a visual acuity of 6/20 could not be obtained with any lens." One eye (6/24) had a sound fundus, except for a large posterior Staphyloma. In all the others, there existed more or less damage to the Choroid and retina. In four the prognosis seemed practically hopeless, as regards sight, but the operation was undertaken as no special damage was foreseen. Brilliant results could hardly be expected
from such a group of cases, but they were satisfactory enough to make me a strong advocate for operating in high hyperopia. How do these words accord with the gloomy forebodings of Mr. Spencer Watkin at the Ophth. Soc. meeting in 1895—"that the operation was not at all likely to attain the object they had in view, which the author suggested it might be likely to effect?" In that case, the operation has attained something which is as not at all likely to do. Coss says "all the patients experienced considerable practical improvement in their power of seeing at a distance."

Dr. Agar Robertson said the results of the operative treatment, as far as statistics showed, were in the whole satisfactory, especially in those cases in which the patients were young, highly myopic—at least 12.5 with healthy fundus—and who were unable to wear glasses. He had operated upon two cases, in both of which a twofold improvement of vision was obtained.

Dr. W. Maxwell (Dublin) then made some remarks on the amount of refractive reduction produced. He said that "even when vision was little improved, the patient was much pleased with the result, showing that the working capacity is improved."

Mr. Juley said his experience was that slightly myopic eyes tolerated extraction very well indeed; in the higher
degrees (105 to 130°), the eye did not endure operation nearly so well.

Dr. Huyler Batten (London) had operated upon six cases of high myopia, three being sufficiently pleased with the result of the first, to wish to have the second eye done also. He regarded the result of the operation, "apart from the actual reduction of the myopia by the removal of the lens, as positively beneficial to the general condition of the eye operated upon." In cases of high myopia with small corneae and presumably small high, refracting lenses, with fairly healthy fundi and no marked evidence of yielding of the sclerotics, he should hesitate to operate unless the degree of myopia was extremely high. "Finally, the operation, as he viewed it at present, was not one of convenience, but of necessity."

Dr. Little (Manchester) thought there was insufficient evidence to show there was practically no danger in the operation, and there was considerable benefit to be derived from it. He was disposed to try it."

He remembered a gentleman with 18 D of myopia and large posterior staphyloma of choroidal patches. After cataract extraction, he could see to read quite well to do his business without glasses—a thing he had never been able to do before. His sight was
Still good 10 years after the operation.

This meeting, therefore, seems to have had an extremely favourable view of this method of treating high Myopia, contrasting strongly with the hostile reception accorded to it, at the Ophth. Society, in 1845.

In looking at the names of the oculists, who have at different times raised doubts or objections as to the utility or even justifiability of this treatment, one is struck by the fact that very few, if any, now, have actually used it; in other words, all those who have carried it out, are satisfied that it is beneficial. This speaks for itself, especially as many of the latter were formerly either distinctly adverse to the operation, or very sceptical as to the benefits to be derived from it. Thus Dr. Argyll Robertson at the above meeting said: "He had only operated on two cases, as his first feeling with regard to the operation was antagonistic, and he had waited till the favourable experience of others induced him to employ the treatment." O'Shelley observed that he had had no experience in extraction of the lens in high Myopia in young subjects; he had always had some doubt about the propriety or safety of operative interference. He thought there was now sufficient evidence to show there was practically no danger,
and there was considerable benefit to be derived from it, and he was disposed to try it." JB has said in introducing the subject had said "I assume it is unnecessary to argue whether or not the method is justifiable. There is already, in my opinion, sufficient evidence in its favour to override the arguments that have been adduced against it, to establish its claim as a recognized surgical procedure."

When we look through the records of the leading advocates of this measure on the Continent, and consider the very small percentage of mishaps that have attended it, I think we may fairly say that the 'laws of theory' advanced by its opponents have been outweighed not merely by the practical 'eye of practice,' nor even by the, but by custom.

In the same year as the above meeting took place (1896) Fukuda published a monograph entitled 'Heiling höchstgradiger Kurzsichtigkeit nebst Angabe einer leichtfasslichen Methode zur schnellen Berechnung der Aenlänge, optische Constanten des Auges und Bildgrössen'. This work should be read by all who wish to become thoroughly acquainted with the operative treatment of high Myopia. Fukuda mentions the various methods that have been tried, with the view of improving the sight in Myopia.
who could not wear glasses, and which have all failed. Some, indeed, were positively injurious, making the eye worse than it was before. Among these varieties of treatment, we find an optical apparatus constructed in 1526 by Stepière, a renowned Berlin optician, whereby it was supposed to be possible to gradually increase the distance at which objects were held from the eyes. Berthold of Gottingen, was responsible for an instrument, to which he gave the name of "Myopodiorothetik" (from ροπος = diopter, and ὀρν. i.e. "Improvement producing"). Felix del. Tell us this produced a great sensation in the ophthalmic world of the time; raised great hopes that a cure for Myopia had been found. It was, however, soon given up. One of the strangest recommendations by way of treatment was that proposed by Egbert Smith Baldwin in 1805, viz. that Myopes should wear curious glasses! on the principle that this would remove all possibility of strain in the accommodation even for near objects. Next we find that Becker in 1835 used magnetism; and he affirmed that a boy with congenital Myopia, who could only read ordinary print at two inches, had by repeated applications of the North pole of a 400-pound magnet, after 4 months been able to read at 18 inches. (See Felixal Monograph p.24).
In 1841, v. Frereich, believing Myopia to be due to congenital shortness or to active contraction of the four recti or the two oblique muscles, thought that the simplest medical cure for Myopia lay in dividing those muscles. This theory the treatment founded upon, was adopted by a large number of oculists, some dividing the ext. and int. Recti, some the two obliques, while others incisedized the whole of the extrinsic ocular muscles! What became of the patients afterwards, I do not know. It certainly should have placed their eyes in a state of rest for some time. Vulpian was the first to make a stand against this misdirected energy.

Coming to more recent years, we next find the eye itself attacked by Balezowski of Paris, who hoped by snipping a crescentic piece from the upper part of the Cornea vallating the resultant wound to guarantee that the transparency of the Cornea would be restored and consequently the amount of Myopia. But the presence of a large opening, by which the aqueous flows away for a long time renders the operation more serious even than a cataract extraction, and even when healing occurs without intraocular suppuration, the Iris is very apt to become adhered to the wound, rendering the pupil very eccentric,
or destroying it altogether. Even supposing this acci-
dent do not happen, the tension exerted by the
sclera is so unequal, that a large amount of ir-
regular accommodation results, so that vision is worse
than it was before the operation, either with or
without glasses.

Other points dealt with by Fabrède in his book, are
the disadvantages of accommodation in high Myopia,
and the proofs that have been brought forward, that
the intraocular tension is heightened by accomoda-
tive efforts; the indications and contra-indications for
extracting the lens in high Myopia; the proper
age; whether one or both eyes should be operated
upon; the method of operation. In the second
part of his works, he goes very fully into the esti-
mation of the length of the Optic Axis, of the optical
constants of the Eye, of the size of the retinal images.

Other papers published last year were by
Stadfel of Copenhagen, dealing with the reduction
affected by removing the lens, & another by Vacher.

II - The Disadvantages of High Myopia.

These are well-known to every oculist; vision in the
case is very obscure & difficult for objects more than a few
Inches away; fully correcting concave glasses, in most cases, cannot be tolerated on account of the great diminution in the size of the retinal images. The apparent removal of objects is, when they can be seen, visual acuity is, almost without exception, considerably reduced, and this, together with the diminished appearance of objects, tends to make the patient hold reading print, or the nearer the eyes, thus putting a strain on the accommodation and consequently one's eyes to give full correction except for distance, in high myopia.

The defective vision is unpleasant in many ways. Even in the slightest degree of myopia, there is a great desire on the patient's part to see well at a distance; we may cite here the well-known case of Pickniwe, who had only 5.50 of myopia. So much did he wish to be able to see at a distance without glasses, that he passed a night with a small bag, containing corn filing, resting on each of his eyes. In the next morning, in consequence of the reduced length of the optic axes, he was able to read, without artificial aid, the numbers on the doors, at the opposite side of the street.

Some writers have become almost poetical on the theme of the defective vision from which myopes suffer. Thus Vossius (Beschreibung für Augenkrankheiten, p. 48)
daß "die vielen Menschen, welche mit hochgradiger Kürzlichkeit behaftet sind, nicht ein Teil der Außenwelt dauernd verschlossen; wie viele Genüsse des Lebens können sie nicht kennen! Die Reize einer schönen Landschaft, einer Fernsicht, gehen einer großen Zahl unserer leidenden Mitmenschen wegen unzureichender Schmerzlosigkeit völlig verloren." Not only do these patients lose the beauties of nature, but they are often in the direst extremities or a burden to their friends or account of their incapacity for work. They are neither fit to see at a distance, as is required plumbers, sailors, etc., nor to work at any employment requiring use of the eyes for reading; also of the professions or acting as a clerk. They cannot see at a distance and in the least named occupations, they must hold the objects close to the eyes, thereby producing great strain on the convergence and possibly some on accommodation. In all the case of Grillparzer, who states in his autobiography, that he had to give up the stage, at the age of 36, on account of Myopia, for which he could not wear the correcting lenses, but which ones did not benefit him much. Yet his acuity of vision remained good up till the time of his death.
at an advanced age. This man would probably have been quite able to remain an actor, if he had had his lenses extracted.

Another drawback of the defective vision, is that myopes do not recognize people, who are passing them, and this may give rise to many unpleasant accidents between him and his friends, or may even lead to serious results, e.g. when an official does not recognize his superior. A myope may even be very un-removedly acquainted with the appearance of his nearest friends. Vossius (loc. cit.) says that one of his patients, a law-student with 3/10 of myopia, became nearly anamorphic after operation and was astonished to find that his father had brown eyes, as he had before always thought they were blue.

A myope assumed that he had recognized his acquaintances by their clothes, that he had been at school six months, without getting to know the appearance of his teacher.

From these examples, we can easily picture the sad state of a high myope, for his hazy idea of things going on around him. This unfitness for almost any employment or recreation.

The disability to wear fully correcting glasses, is due in the first place to the great diminution of the
Retinal image: apparent removal of objects. Even assuming the visual acuity to be normal, what is practically never so, in high myopia, these two factors, in many cases, make the patient prefer to see dimly without a glass.

Although there are other factors that convey the idea of distance, e.g., loss of definition of details, over-life 

one of the chief is diminished size video this that produces the apparent removal of object, the

Apparent diminution of the object, is of course, due to actual diminution of the Retinal Image, which diminution bears a definite relation to the position of the nodal point of the eye. In his monograph, Fekeide proves this as follows—(see fig.)

---

Let AB be the object, K the nodal point of the eye without glasses. K' the nodal point of the corrected eye. R the position of the Retina. then AB represents the retinal image of AB and a'b' its image, when the glass is before the eye.
On account of the smallness of a'b, the eye, which without glasses, was used to see the image of the size a'b, reckons the distance of the object as B'K, as this is the distance of an object giving an image of the size a'b, when glasses are not worn.

Now, if the visual angle A'B'K'B be represented as \( \alpha' \) and A'K'B as \( \alpha \), then,

\[
A'B'K = B'K \tan \alpha = B'K \tan \alpha' = BK \tan \alpha\]

Thus, \[
\frac{BK}{B'K} = \frac{\tan \alpha}{\tan \alpha'}
\]

On the other hand, \[
\frac{a'b}{ab} = \frac{BK \tan \alpha}{Rb \tan \alpha'}
\]

\[
\therefore \quad \frac{a'b}{ab} = \frac{\tan \alpha'}{\tan \alpha}
\]

and, thus \[
\frac{BK}{B'K} = \frac{a'b}{ab} \quad (1)
\]

i.e., the distances, at which the corrected and uncorrected eyes respectively estimate the same object, vary inversely with the size of the Retinal Image. Further, we can, without important error, consider the lines A'a' \& B'b' as parallel. Then we get

\[
\frac{a'b}{ab} = \frac{K'b'}{Kb}
\]

But by (1) \[
\frac{a'b}{ab} = \frac{BK}{B'K}
\]

\[
\therefore \quad \frac{BK}{B'K} = \frac{K'b'}{Kb}
\]
i.e. the distances, at which the uncorrected eyes respectively appear to see the same object, vary almost inversely as the distance of the nodal point from the Retina.

But there are other points to be considered, why they correct glasses are not tolerated. Very slight shifting of the position of such glasses produces a great alteration in their respective value; thus, if they be approximated to the eye, their value is increased; the Myopia becomes uncorrected; vice versa, if too far away, the Myopia is uncorrected. Needless to say, the lenses must be so placed in the frame, that the Visual Axes will pass perpendicularly through their centres, otherwise an Astigmatic or a prismatic action will be exerted.

Thus a Myope usually has a somewhat uncertain field, as he is not sure of the exact level of the ground, since he sees it through the lower portion of his glasses. That through the centres.

Another point is that strong concave lenses disperse the rays of light that pass through it, and when we add the resulting defective illumination to the smallness of the images of the impaired visual acuity of the Retinal elements, we can easily form an idea of the reason why a high Myope cannot wear
correcting glasses. That the visual acuity is diminished in high myopia, is well known and was shown at the British Medical Association meeting in 1896, in a table compiled by Cross of Bristol, which I give below.

**Table of Myopia in cases treated by Mr. F.R. Cross, F.R.C.S.**

<table>
<thead>
<tr>
<th>Myopia</th>
<th>Case</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>-0.50 D</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>-0.75 D</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>-1.00 D</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>-1.25 D</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>-1.50 D</td>
<td>5.6</td>
<td></td>
</tr>
<tr>
<td>-1.75 D</td>
<td>5.5</td>
<td></td>
</tr>
<tr>
<td>-2.00 D</td>
<td>3.3</td>
<td></td>
</tr>
<tr>
<td>-2.25 D</td>
<td>10.7</td>
<td></td>
</tr>
<tr>
<td>-2.50 D</td>
<td>8.4</td>
<td></td>
</tr>
<tr>
<td>-2.75 D</td>
<td>3.4</td>
<td></td>
</tr>
<tr>
<td>-3.00 D</td>
<td>10.4</td>
<td></td>
</tr>
<tr>
<td>-3.50 D</td>
<td>11.4</td>
<td></td>
</tr>
<tr>
<td>-4.00 D</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>-5.00 D</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>-6.00 D</td>
<td>10.3</td>
<td></td>
</tr>
<tr>
<td>-7.00 D</td>
<td>10.8</td>
<td></td>
</tr>
<tr>
<td>-8.00 D</td>
<td>9.2</td>
<td></td>
</tr>
<tr>
<td>-9.00 D</td>
<td>5.0</td>
<td></td>
</tr>
<tr>
<td>-10.00 D</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>-11.00 D</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>-12.00 D</td>
<td>6.5</td>
<td></td>
</tr>
<tr>
<td>-13.00 D</td>
<td>5.9</td>
<td></td>
</tr>
<tr>
<td>-17.00 D</td>
<td>3.1</td>
<td></td>
</tr>
</tbody>
</table>

From this table we see that the average amount of vision obtained by glasses, progressively diminishes as the degree of myopia increased, i.e., was in inverse ratio to the amount of the myopia.

The diminished acuity of vision is due partly to the
changes of the back of the eye (sclero-chorioiditis post), perhaps disseminated choroiditis, may be involving the macular region; floating specks in the vitreous may be due to amblyopia, from the retinal elements having become less sensitive than normal, since they have not been used to having definite vacuolated images focused upon them.

Schell (q. q. p. 34) says that, in all his experience of cases of myopia, he has only met with one, in which the patient wore glasses, of eighteen, and his vision was so reduced, that he could only count fingers at a short distance.

Pflega even puts the limit, at which the patient usually begins to find trouble in wearing glasses, as low as 0.75.

III. The Advantages of Aphakia.

What are the advantages to be gained by removing the lens from a highly myopic eye? The advantages claimed are as follows:

1. Vision at a distance is greatly improved.
2. Relief is again rendered fit for near-work.
3. Increased range of vision.
4. Restoration of binocular vision.
\( \text{ Arrest of the progress of the myopia.} \)
\( \text{ Stopping o. a brook when reading, or in days away with.} \)

1. \text{ Improved vision at a distance.} - This is the first thing that strikes the patient and makes him thankful he has undergone the operation, for, either with or without glasses, he is able to see and distinguish objects that formerly he could see not very accurately. As a rule, the improvement is very considerable, vision being increased at least two or three-fold; in exceptional cases, it has been augmented in a really wonderful degree, e.g., in the first case reported upon by Takahashi \( \frac{1}{20} (N=20/25) \), the vision five months afterwards was \( \frac{1}{30} \), i.e., more than a twofold improvement. In a few cases, it has been reported, where the visual power was not increased, there was improved capacity for work, which satisfied the patient.

2. \text{ Ability for near work.} - Although (1) is the most pleasant, this is the most useful gain. It is learnt on account of their inability for seeing near hand for any length of time, that renders it so hard for highly myopic patients to find a suitable occupation. It is obvious that a person cannot place his head two or three inches from a piece of
paper, when he is writing, not only because he would be in the way of the pen, but because of the great strain thrown on concentration, unless one gets things consequently such work soon causes Asthenopia, or it head ache, lacrymatism, etc. forth, besides tending to the increase of the Myopia. Now, when the lens has been removed, and the patient has only a slight degree of Myopia, or is even Emmetropic or slight Hypermetropia, then either with or without glasses, as the case may be, he is able to write or read with ease at say 25 to 30 cm. without any strain being thrown upon his convergent powers. Accommodative effort of course is abolished.

(iii) Increased range of vision. The objection of Dr. Dal..., that, by producing Aphakia, we take away the power of accommodation, and which has formed one of the two main points (the other being supposed liability to detachment of Retina) brought forward by the opponents of the operative treatment of high Myopia, has been shown to have no real support. On the other hand, this fact is now considered to be beneficial, as we shall see subsequently. In high Myopes, who cannot tolerate glasses, the range of vision, for practical purposes, may be considered as nil: i.e. supporting a myope of 15 D. his ve...
The point of clear vision is about 2 1/4 inches; he cannot therefore bear a range of any practical utility, therefore the power of accommodation, which he possesses, is of little or no use to him.

Up till quite recently, it was thought we should only make matters worse by removing the crystalline lens, as there would then be no accommodation at all and consequently no range of vision. The fallacy of this was first pointed out by Thiers at the Edinburgh Ophthalmic Congress in 1878, by the following table of 16 cases, in which he carefully tested the range of vision in patients, whom he had operated upon for high hyperopia.

1. Man, age 30, formerly + M 15.0, reads + 8.0 Jaeger at 12.6 to 54 cm.
2. Woman, age 23, formerly + M 13.5 D, reads same + 10.0 at 7 to 38 cm.
3. Man, age 41, former + M 18.0 reads same + 4.0 at 12 to 75 cm.
4. Man, age 24, former + M 13.0 + 5.0 reads same from 10 to 37 cm.
5. Man, age 36, former + M 17.0 + 4.0 at 15 to 39 cm.
6. Woman, age 18, former + M 13.3 D + 9.0 at 10 to 38 cm.
7. Woman, age 36, former + M 18.0 + 5.0 at 13 to 35 cm.
8. Woman, age 30, former + M 17.0 + 9.0 at 10 to 31 cm.
9. Boy, age 15, from M 1/6 D e + 8 D at 20 to 56 cm.
10. Woman, age 36, from M 1/6 D e + 6 D at 18 to 49 cm.
11. Man, age 28, from M 1/3 D e + 4 D at 9 to 33 cm.
12. Man, age 31, from M 1/6 D e + 4 D at 12 to 57 cm.
13. Man, age 38, from M 1/6 D reads at 23 to 52 cm.
14. Man, age 29, from M 1/3 D reads e + 8 D at 20 to 41 cm.
15. Girl, age 21, from M 1/3 D e + 8 D at 23 to 50 cm.
16. Man, age 23, from M 1/6 D e + 6 D at 25 to 50 cm.

From this table, we find that the patients had, respectively, the following range of vision in aphakia, viz. 42, 31, 63, 27, 24, 28, 22, 21, 36, 31, 24, 25, 29, 21, 27 to 25 centimeters. The least of these distances, viz. 21 cm, shows us a very considerable range of vision, quite enough for practical purposes. To what is this "pseudo-accommodation" due? - Thier explains it as follows. When the lens is extracted from an emmetropic eye, a convex lens of about 14 D is subsequently required for near vision. The rays unite on the retina, under a comparatively large angle (Fig. 1), consequently, even a slight shifting of the
object produces considerable circles of diffusion and vision is consequently blurred. On the other hand, in an aphakic eye, previously highly myopic, and which, for present purpose, we will consider has become emmetropic, the rays meet under a much smaller angle (Fig. 1) and consequently, considerable shifting of the object may take place without interfering with clear vision, as the circles of diffusion produced on the Retina are small. Further, the patient has been used to circles of diffusion, and has learnt to ignore them to some extent.

How does pseudo-accommodation differ from accommodation proper? Firstly, in its mode of production, as we have just seen. Then, in ordinary accommodation, vision is equally clear, and can be over the whole range of vision, whereas in pseudo-accommodation, vision is most clear at the point for which the eye is focused, and gradually gets more and more ill-defined, as the object is moved away from that point, whether towards or away from the eye. Lastly, normal accommodation raises the lenticular a certain amount of brilliancy to the eye. This tends to increase the myopia present; pseudo-accommodation involves no effort of any nature.
ocular muscle and consequently its use does not exert any influence upon the course of the myopia. In other words, normal accommodation is active and depends upon the activity of the ciliary muscle. Its intensity is passive and depends upon the optical construction of the eye.

IV) Restoration of Binocular Vision. As is well known to every oculist, binocular vision is frequently lost in the higher degrees of myopia, either for near or for both near and distant sight. This is due, of course, to the difficulties of converging partly from the shape of the eyes partly from the accommodation not being required. Consequently, the Internal Recti become weak thereby being impeded in their action by the elongation of the eye bolls, the patient suffers first from Asthenopia then from latent finally manifest divergent Strabismus. At first, there may be diplopia, but after a time one image is suppressed. Now, if a case of myopia, in which divergence occurs only when looking at a near object, have the Crystalline Lens removed from both eyes, we may hope to restore binocular vision stop partial divergence recurring. Why is this? The explanation is simple: near-work, e.g.
reading or writing, is now done, not at 20 or 30 inches, but at the ordinary distance of say 10 to 20 inches; consequently the amount of convergence required to see binocularly is comparatively slight, and can be produced by the Internal Recti without undue effort, though it usually requires stereoscopic exercise to get them more to work together.

When there is a deficient accommodation for distant objects, we cannot expect the contraction of the Crystalline lenses to produce any change in it; some special operation, e.g. advancement of the 2d Recti will be required in addition.

1. Affect of the Myopia. This advantage we can hardly yet accept as proved, since it requires a considerable number of years to be observed on a series of persons, before a positive assertion can be made on this point. We can either assume (1) cases in which both eyes are operated upon, in which we have to note (i) whether the amount of refraction had previously been increasing up to the time of the operation, or whether it had become stationary; (ii) whether the amount of refraction at the time of the operation remain stationary afterwards, and if so, for how long; or whether it (the change at
The back of the eye) goes on increasing, or if so, whether
the increase be as rapid, or more so, than before.
(b) cases in which only one eye is operated
upon. Here we have a much better opportunity
of judging the ultimate result of the operation, since
we can compare the operated with the unoperated
eye; and observe whether there be any difference
in their progress. A class of cases that come
under this heading, consists of those patients,
who were operated upon years ago, for a
congenital or traumatic Cataract, and who
were suffering at the same time from Myopia
Fukuda maineio (Monograph, p. 70) that, as a rule,
either total or partial arrest of the progress in
the Myopia results. In this instance, he has
been supported by Vossius, Stettler, v. Hefkel and
others. At the Heidelberg Congress 1893, he said: "Schließlich
lade ich bei Besprechung mehrerer Operatoren durch
5, 4 or 3 years' intervals in the follow-up of the patients,
dass ein Stillstand in der Zunahme der Refraktion
eingetreten ist. — Auch der Spiegelbefeund
ist während der Dauer der Jahre constant
geblieben." He cited, by way of example, a gom-
ness, who originally had M. 20D; after operation
5.5D Myopia remained. This had not increased.
four years afterwards; also a boy of 12, who had
M 15-6, who became exomotropia in Aphakia.
O had remained thus for 3 years.
V. Hippius considered it was still an open question
whether the removal of the lens prevented further
increase of the Myopia or not. He did not think
the accommodation was used to a sufficient extent
by Myopes, to react an injurious effect on the eye.
Falkenau answered that young myopes use their ac-
commodation very much; e.g. when a M 15-6
holds an object only 1 to 3 cm. from the eyes;
they accommodate so easily, that they do it unconsciously.
V. Hippius has subsequently stated that in none of his
cases could be establish an increase in the Myopia
that they were observed for two years.

Lindner also, after observing a number of cases, during
two years, has expressed expressed the opinion that also
with the improvement of Vision, objects can be held
further from the eye, then an important obstacle
is introduced against the further increase of the
Myopia. "To this progress, however, a relatively good
Vision is necessary, and in notoriously bad eyes,
 Arrest has not been observed." (Falkenau, Monat. p. 71).

Vogler says that he stated, in his first publication on
the subject, that the refraction remained stationary.
after removal of the lens. He observes further (p. 9) "à
notre Congrès de 1894 j'apportais une statistique de
23 cas dans lesquels je faisais ressortir la réfrac-
tion de l'œil avant et après l'opération, sa
acuité visuelle après correction, puis la réfraction actuelle
de l'œil non opéré, son acuité visuelle et la
différence de réfraction des yeux après l'ex-
traction du cristallin et actuellement. La com-
paraison de tous ces chiffres conduisait le res-
signement fournis au Congrès d'Heidelberg (1893).
Elle montrait que l'extraction du cristallin ne
sémente arrêté la marche de la myopie, mais
favorise ou provoque un léger retard en arrière
par l'œil opéré, alors que la myopie de l'œil non
opéré continue à progresser lentement dans la
majeure partie des cas."

Mayer, Better, had a patient, in whom the Hypermetro-
pia, resulting from the operation, not only did not
decrease, but actually increased for a few
weeks from +1.5 D to +4 D.

On the other hand, it has been maintained by some
that the myopia is not arrested. Thus Meyer (cited
by Braun 29) operated on a young myope with lamella
Cataract, but it had no effect on the progress of the
change in the fundus; whilst Punnie and (ibid) found
he had to weaken the reading glasses gradually to +2, after the removal of a congenital Cataract.

At the Heidelberg Congress 1895, Weitstiff mentioned a case, in which he had operated on a very myopic patient for perinuclear Cataract, 7 years previously. Since that date, the Myopia had slowly increased at the same rate, as it had done before the operation. Our conclusion, therefore, must at present be, that whilst the operation prevents or retards further progress in some cases, it does not do so in all.

Why should removal of the Crystalline Lens render the Refraction stationary? — Contrary to what one would at first sight suspect, Accommodation is much used by young myopes, who may be suffer from "spasm of the Accommodation", thus rendering their Myopia apparently much higher than it really is. For example Böckler observed a case of Myopia apparently of 7 D, which, after Atropia had been intensified, dropped to 1.5 D. Numerous other cases have been recorded. This spasm of the accommodatio has a very important influence in tending to lead to increase in the length of the Optic axis & hence of the Myopia (Fuchs, Angenheilt. 1889; Maertner others). That the use of the accommodatio increases...
The intraocular tension was first shown by Coecina in 1852 and subsequently, by v. Graefe in 1856, who observed the vessels at the back of the eye with the opthalmoscope, during accommodation in relaxation.

Hansen & Völkmann (Graefe's Arch., Vol. IV. 1. p. 281) have first in dogs, cats & monkeys, then in men, that the choroid is drawn forward during accommodation. This produces tension on the vessels, vis a ditaem from them, thereby increasing the tension in the vitreous.

When, therefore, Aphakia is produced in a myopic eye, and we thereby remove the possibility of accommodative effort, (i) we place the choroid in a position of rest, thus giving the best chance for the subsidence of any inflammatory changes; (ii) we do away with the increase of tension associated with accommodation. We thus, in the first place, tend to keep up the resisting power of the coats of the eye, and secondly, to reduce the expanding force.

IV - Explanation of the Improved Vision.

It was seen, after the first case or two had been operated upon, that there was very great improvement of vision. Fukuda was inclined to think that this was due to shifting forward of the nodal point or
consequent enlargement of the Retinal image. He quotes
Mauthner (Graef Archiv. xxxvi. 2) to show that, when
the lens is removed from an eye in 20 D myopia,
the ratio of enlargement of the image is as 1 : 1.33.
Schlegl (Graef Archiv. xxv. p. 109 of 1895) restored
in Oph Rev June 1895) says that "the calculation of
the size of the image is greatly simplified by the fact
that a lens, of whatever value, if placed at the an-
terior focus of the eye, does not affect the size of the
image, but only its position. Hence it follows that
the size of the image in the corrected myopic eye
is the same as in the Emmetropic "normal eye".
This image, compared with that of the aphakic em-
metropic eye, is shown by a simple construction
to be of the same ratio as the distances between
the nodal point and the Retina in both cases. In
the two instances in question, the anterior focal
length of the Emmetropic eye being 15.5025 mm.
This and focal length of the Cornea, 13.266 mm.
This ratio is approximately 2 : 3; or, in other
words, the Retinal image is half so large again
as in the Emmetropic normal eye.
But this enlargement is not sufficient to
account for a 3 or 4-fold, much less a
twofold improvement of vision. There is not
the slightest reason to think that any increase in the
sensitiveness of the rods or cones of the retina is produced
by the operation, and hence Reimbold (Monograph p. 55)
says that he no longer uses the term "Verbesserung
der Scharfe" but employs the expression "Scharfe-
nögen".

Scheiner (loc. cit.) says that in comparing the effective
ness of an aphakic eye with the same eye with
the lens in situ, we have to consider not only the
size of the image, but also its distinctness.
The distinctness (D) is directly proportional to
the size of the image (q) and the intensity of light (I)
and inversely to the dispersive coefficient (D). In other words

\[ D = \frac{q I}{D} \]

we have already considered the enlargement of the
image. Scheiner says that, with a focus of the same
size, the amount of light admitted into an aphakic
symplectic eye is twice as great as that ad-
mitted formerly into the eye, when aphakic and
corrected by a concave lens. But, if the image
is larger, the light spread over a greater area,
the intensity is nearly the same in both cases.
As regards dispersive force of light rays, it
is evident that, with rays being rendered divergent by a strongly concave glass, a large numbe
will not enter the pupil. We can form a good idea of the difference in this respect, produced by aphakia, if we first focus some light on a piece of white paper with a convex lens. Note that if we focus a bright spot is produced with a surrounding dark ring; on the other hand, if a concave lens be used, we get a dark centre with a light ring around. Since the focus falls on the macula lutea, it is evident what an advantage a convex will have over a concave lens.

Further, dispersion is less in the aphakic emmetropic eye, since much of the latter has only one breaking surface (the cornea), as against five in the corrected myopic eye. There is also very considerable spherical chromatic aberration when a strong concave lens is used. Compare Fig. 1 and Fig. 2.

(Fig. 1) [Diagram of an emmetropic eye]
(Fig. 2) [Diagram of a myopic eye with a corrective lens]

Fig. 1. The x shows the refracting surface of the aphakic emmetropic eye; Fig. 2. The five crosses show the five refracting surfaces in the corrected myopic eye.
V. The Difference in Refraction produced by Extraction of the Crystalline Lens.

Mauthner (Opt. Fehler, p. 232) thought that the extraction of the lens from an eye, of any refractive power, produced a difference in the value of +10 D. Thus, supposing the eye to be myopic + dioptric, its refraction in aphakia = (x + 10) D, e.g., take an eye with -15 D myopia; in aphakia, Mauthner thought (-15 + 10) D = -5 D would remain. This erroneous conclusion has been rectified by other authors. Its falsity, however, was very quickly shown when a few cases of myopia were actually treated by removal of the lens; it was then found, that the effect produced was greater in myopia than in emmetropia and greater in emmetropia than in hypermetropia. Further, the higher the degree of original myopia, the greater the result produced on the refraction; the higher the degree of the original hypermetropia, the less the effect produced. Thus, Eitner’s17 estimate, that an eye hypermetropia 12 D, a difference of only 4 D, could an emmetropic eye should require, when aphakia, a glass of +8.25 for distance, a difference of +8.25 D. (Eitner explains the difference between this glass, the usually found in practice +10 D, by supposing a slight
sharpening of the optic axis to result in an eye, where the lens is extracted. He thinks that an eye originally corrected by a lens of -20 D, becomes emmetropic in aphakia — a difference of 20 D, five times the difference produced by extracting the lens from an eye corrected by +5 D. How is this accounted for? Fickels, Schweigger, Thul, Vossius, Brief others were inclined to ascribe this phenomenon to the refractive power of the lens being increased in high myopia. Although this seems to be the explanation in exceptional cases, if part of the increased difference, it is not necessary to assume that the lens, as a rule, has any alteration, i.e., in its refractive value in high myopia. As we all know, the effect produced by a convex lens increases, as we move it away from the eye. Similarly, the effect of the crystalline lens (though its refractive power be unaltered) in high myopia, is increased by the Retina being further from it than in Emmetropia, due to the bulging of the posterior part of the eye. By the same reasoning, the effect produced on light rays by the lens in Hypermetropia, is less than that produced in Emmetropia, and hence the difference in refraction, resulting from aphakia, will be less. Greff has observed several depths of
myopia produced by forward displacement of the lens, occurring in connection with a perforating wound of the cornea escape of the aqueous. Vossius relates a most interesting case, bearing on this effect of displacement of the lens. A patient, aged 55, came to him with a history of the right eye being destroyed by a blow from a stick, when he was six or seven years old. About the same time, he stumbled over the root of a tree and soon afterwards, he noticed vision was defective in the left eye. When he bent forwards, the right became practically lost, so that he was unable to distinguish people close to him. Or tilting his head backwards, vision again became comparatively good. What was the explanation? When he bent forwards, the lens became dislocated into the anterior chamber & when he bent back his head, the lens returned behind the iris. When the lens was in the latter position, patient had +5 D of myopia 2 V = 20/50; when in the former, there was +15 D of myopia 2 V = 20%. Vossius extracted the lens, the result being that the eye became hypermetropic 13 D. Now, a refraction of +13 D results when the lens is removed from an eye with a hypermetropia of +4 D (Landolfi).
to 75 (Operations), and yet this eye had a degree of myopia, when the lens was behind the iris, increasing to 150, when the lens came in front of the iris; in other words, taking Stephanel's figures as correct, the crystaline lens caused the refraction from +40 to -40, all behind the iris (a difference of 80), whilst its forward displacement added another -115, a total effect of -195 being produced. Vossius thinks the myopia present when the lens was behind the iris, presumably fairly in situ, is regarded as distance from the retina, 6 cm, due to rupture of the capsule of zinn, and consequent increased contractility of the lens. The increase to -150, when the lens came into the anterior chamber, must have been due entirely to the displacement forward of the lens, Vossius also noticed a markedly spherical form of the lens in a case, where he removed it for myopia of 80 D, the refraction in aphakia becoming -150.

But these cases are exceptional; he thinks, in such the lens has assumed the spherical form from long-continued soft-seated relaxation of the capsule of zinn, due to spasm of the accommodation resulting from much near-work in childhood. Trubetza thinks (Monograph p.72) that the form of the lens depends not on cramps of the accommodation, but
rather as a congenitally abnormal thickness of the lens.

The great difference in refraction produced by Aplastic in a highly myopic eye has been explained as due to the distance at which the correcting lenses are placed in front of the eye. At the Heidelberg Congress 1874, Pflüger thought that a myopia corrected by -15 D at the usual distance from the eye became hypermetropic in Aphakia. Here, the usual correcting glass of +10 D for an aphakic eye, originally emmetropic, corresponds at 13 mm. in front of the eye to a hypermetropia of 12.5 D. To correct a myopia of 12.5 D, it requires a glass of -15.5 D placed 5 mm. before the eye, of -16.75 D at 13 mm., or -17.8 D at 20 mm. In other words, extraction of the lens from an emmetropic eye produces really a hypermetropia of 12.5 D; i.e., thought that a Myopia of 12.5 D, indicated by a glass of -15.5 D or more, according to its position, should become emmetropic in Aphakia. It is recommended that the Myopia should be estimated by Pflüger's method, which consists in having a number of concave glasses of -15 D placed in front of the eyepiece of the Ophthalmoscope, so as to come close to the eye, whose refraction can then be estimated by the direct method, "without greater dif-

difficultly than in emmetropia or a slight amount of refraction. This explanation might have held good, if the refraction had been loosely calculated by means of glasses. But this had not been so. Schweigger had pointed out the possibility of error arising in this way. He had tried to avoid it, as much as possible, by making the patient himself hold the glass (placed in a frame with a handle) as closely as possible to the eye. He has since used another method by means of an Electric Ophthalmoscope. The image of the electric lamp is reflected back from the Retina and forms another image at the far point of the eye. This is observed with a strong converging lens at a distance from the eye measured. It is then easy to calculate the exact amount of myopia. By these methods, it has been shown, that the great difference produced in the Refraction is not apparent only, but real. Opepe (Incis.) has shown, however, that in the greater number of cases, it is unnecessary to suppose that there is any increase in the actual refractive power of the lens — anything can be explained from the abnormal length of the eye, and not only so, but it is possible by calculating the length of the eye, to say what its refraction will be in Aphakia.
He deduces a formula for this purpose. This has previously been done in 1878 by Badal (Annal. Oculist.) by Ostwald (Rev. d'opt. 1892), but Gerovitch thinks his second better with the results of practice. He considers, as do nearly all of the great classical authors, that Myopia, more particularly high Myopia, is due exclusively, in the great majority of cases to lengthening of the optic axis. "The optic axis of an emmetropic eye being 24 mm., each mm. added to this produces an augmentation in the refraction of 3.8, calculating from the anterior focus. Thus an eye + myopia 12.5 has an optic axis of \( 24 + \frac{12.5}{3.8} = 28 \) mm. The action of the lens produces a very simple optical system, of which the refraction may be easily calculated. On the one hand, we have a Cornea of 7.77 mm. radius of curvature (this is the mean of the figures given by the classical authors, and it remains almost constant in the majority of cases of anomalous refraction) of 32.5 B., removing power; on the other hand an optic axis of 28 mm. Now the simple fraction \( \frac{25}{28} \) shows us that, to make this eye emmetropic, it requires a Cornea possessing a refracting power of 35.75 B. As it only has one of 32.5 B., this eye is necessarily hypermetropic to the extent of 35.75 - 32.5 = 3.25."
"If we call $R^*$ the original correcting glass, placed at the anterior focus, $R^+$ the correcting glass of the apheric eye, at the level of the principal plane, we get for all cases:

$$R^* = \frac{1000}{24 + \frac{R^+}{3}} \text{ D.}$$

By the aid of this formula, it will be found that an eye, +20 D myopia, becomes anametropic in Aphereia, those with less become hypermetropic, and those with more still remain more or less anametropic.

Spima then draws up three tables, the first being a comparison between the values of the original correcting glasses, 13 mm. before the eye, at the principal plane of the eye, before or after removal of the Crystalline lens, and at 13 mm. in front of the apheric eye, as estimated by his formula. The first gives the real, the apparent diminution in refraction. This is done for every degree of refraction between 1 that corrected by a glass of +8 D at 13 mm. distance, to one corrected by -30 D at the same place e.g.

<table>
<thead>
<tr>
<th>Correcting glass at 13 mm.</th>
<th>At principal plane</th>
<th>Apheric eye at 13mm.</th>
<th>Astronomical sum of Columns 2 and 3</th>
<th>Sum of Columns 5 and 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>-16 D</td>
<td>-12.9 D</td>
<td>+1.6 D</td>
<td>14.5 D</td>
<td>17.5 D</td>
</tr>
</tbody>
</table>

In the 2nd table, he compares the results published by the various operators individually, up to the time of his
The paper of 1895, with those obtained by the use of this formula. This table includes 14 cases by Winkler, 5 by v. Schroeder, 2 by Martin, 5 by Wolff, 14 by Schweiger, 9 by Thier, 23 by Wunder, 36 by Pfüger, 2 each by Schirmer, Widmark, 2 each by Moore, 3 each by Nussinov, 5 by Kupper himself. Total, 123 cases.

In looking through this table, it is seen that in 11 cases (1/12), the figures obtained in practice are exactly the same as those obtained by calculation. In 83 cases (more than 2/3) the two values differ only from ± 0.25 to ± 2.0. In the remaining 29 cases (1/4), the difference is greater. How are these exceptions to be accounted for? "They are not surprising, when one considers the numerous circumstances, which can affect either the determination of the original refraction, or that in aphakia; and when one thinks of those, which can modify the optical effect of the operation in such a way, that it diverges somewhat from the theoretical calculation: modifications in the curvature of the cornea, probably also the length of the optic axis; firstly, when we remember the values, which enter into the composition of the formula (refractive power of cornea, length of optic axis, etc.) are the theoretical values,
value, subject to variations in particular cases, and
that a small variation in these values produces
immediately a perceptibly different value of $R$.

The differences that may result from different
methods of estimating the refraction, I have already
alluded to.

Occasionally high myopia may be largely due to in-
creased curvature of the Cornea (Myopia of Curvature)
and in such a case, there will be a large difference
between the degree of refraction actually obtained in
practice & that obtained by calculation, unless the
curvature of the Cornea has previously been estimated
& allowed for. Thus it has been recommended that
the curvature of the Cornea should in all cases be
reckoned, when we are going to remove the lens for high
myopia.

A slight retraction of the Cornea, perhaps gall the cost
of the eye, producing shortening of the optic axis, is be-
lieved by many oculists (s.s. Vacher, Pflüger Siegrist, &
Eppen) to follow removal of the lens. Pflüger &
Siegrist even think that a slight escape of Vitreous,
at the time of the operation, is of advantage, as the
retraction of the ocular tunicies will be more marked.

In his third table, Eppen compares the mean of
the results obtained by the operators above-mentioned.
with the calculated effect, embracing cases with 90 degree myopia up to others with no amount. I take the liberty of inserting it below; it will be seen that the differences between the actual and the calculated results are mostly very trifling.

<table>
<thead>
<tr>
<th>Myopic Primities</th>
<th>Myopic Results Obtained</th>
<th>Venet Calculate</th>
<th>Ecart</th>
</tr>
</thead>
<tbody>
<tr>
<td>9 10</td>
<td>14.25</td>
<td>+ 4.25</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>+ 3.75</td>
<td>+ 2.25</td>
</tr>
<tr>
<td>11</td>
<td>4.75</td>
<td>+ 3.5</td>
<td>+ 1.25</td>
</tr>
<tr>
<td>12</td>
<td>3.5</td>
<td>+ 3</td>
<td>+ 0.5</td>
</tr>
<tr>
<td>13</td>
<td>3.75</td>
<td>+ 2.75</td>
<td>+ 1</td>
</tr>
<tr>
<td>14</td>
<td>3</td>
<td>+ 2.25</td>
<td>+ 0.75</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>+ 2</td>
<td>- 1</td>
</tr>
<tr>
<td>16</td>
<td>1.25</td>
<td>+ 1.5</td>
<td>- 0.25</td>
</tr>
<tr>
<td>17</td>
<td>0.5</td>
<td>+ 1.25</td>
<td>- 0.75</td>
</tr>
<tr>
<td>18</td>
<td>0.25</td>
<td>+ 0.75</td>
<td>- 0.5</td>
</tr>
<tr>
<td>19</td>
<td>0</td>
<td>+ 0.5</td>
<td>- 0.5</td>
</tr>
<tr>
<td>20</td>
<td>M 1.25</td>
<td>0</td>
<td>- 1.25</td>
</tr>
<tr>
<td>21</td>
<td>0</td>
<td>- 0.25</td>
<td>+ 0.25</td>
</tr>
<tr>
<td>22</td>
<td>2</td>
<td>- 0.5</td>
<td>- 1.5</td>
</tr>
<tr>
<td>23</td>
<td>0.5</td>
<td>- 1</td>
<td>+ 0.5</td>
</tr>
<tr>
<td>24</td>
<td>1.5</td>
<td>- 3.25</td>
<td>+ 1.75</td>
</tr>
</tbody>
</table>

Another method of calculating the change in refraction produced by aphakia, has been brought forward by
Staf~feldt of Copenhagen. He also disagrees with the opinion that there is a "vermittelndes optisches, das der Linde "v. myggen," an assumption, which is not only quite unnecessary, but quite incompatible with the changes which occur in the refraction after extractions of the lens. He points out that though an aphthe previously metamorphic usually requires +10 D for distance, it would be a great error to say that the crystalline lens had an after value of +10 D, since if it was situated far nearer the Retina than the artificial lens, and consequently requires to be of a much greater value than the latter, in order to focus parallel rays on the Retina (Staf~feldt estimates the ordinary value of the crystalline lens at about +16 D). He says "If we wish to render the refraction the various degrees of axial anastigmatism will give after extractions of the lens, we have first to seek" (knowing the optical constants of the eye) "the point, which is conjugate with the far-point, i.e., the position of the Retina, and the the point which, in the aphthe eye, will be conjugate with the position of the Retina, i.e., the new far-point." There is a considerable difference between the figure obtained by his method of Reponis, increasing with the amount of original hypermetropia remaining.
with the amount of myopia, till we get to -20.0, when they are practically the same. After that, they again begin to differ.

I shall now give the fields' table. Then fix the same difference produced by subtracting the lens in the same degree of refraction, as estimated by Spener.

| +7.0  | +15.0 | -9.0  | +5.5  |
| +5.0  | +13.7 | -11.0 | +4.4  |
| +3.0  | +12.5 | -13.0 | +3.4  |
| +1.0  | +11.3 | -15.0 | +2.3  |

| +10.7 | -17.0 | +1.3  |
| +10.2 | -18.0 | +0.2  |
| +8.9  | -21.0 | -0.8  |
| +7.8  | -15.0 | -1.7  |
| +6.6  | -25.0 | -2.7  |

---

Table of Similar Cases, Estimated by Spener's Method.

<p>| 7.0  | 7.8  | 13.6 | 11.5 |
| 5.0  | 5.4  | 12.3 | 10.75|
| 3.0  | 3.1  | 11.0 | 9.75 |
| 1.0  | 1.0  | 8.7  | 8.75 |
| 0    | 0    | 8.2  | 8.25 |
| -1.00| -1   | 8.6  | 7.75 |
| -8.00| -2.9 | 7.5  | 6.75 |</p>
<table>
<thead>
<tr>
<th>Original correcting glass at 15 mm</th>
<th>Grip correcting glass at principal plane</th>
<th>Correcting glass at principal plane of the aphakic eye</th>
<th>Correcting glass of 1 aphakic eye at 15 mm</th>
</tr>
</thead>
<tbody>
<tr>
<td>-5.0</td>
<td>-4.7</td>
<td>+6.5</td>
<td>+6</td>
</tr>
<tr>
<td>-7.0</td>
<td>-6.3</td>
<td>+5.5</td>
<td>+5</td>
</tr>
<tr>
<td>-9.0</td>
<td>-7.9</td>
<td>+4.5</td>
<td>+4.25</td>
</tr>
<tr>
<td>-11.0</td>
<td>-9.5</td>
<td>+3.6</td>
<td>+3.5</td>
</tr>
<tr>
<td>-13.0</td>
<td>-10.9</td>
<td>+2.8</td>
<td>+2.75</td>
</tr>
<tr>
<td>-15.0</td>
<td>-12.2</td>
<td>+2.0</td>
<td>+2</td>
</tr>
<tr>
<td>-17.0</td>
<td>-13.5</td>
<td>+1.2</td>
<td>+1.25</td>
</tr>
<tr>
<td>-19.0</td>
<td>-14.8</td>
<td>+0.5</td>
<td>+0.5</td>
</tr>
<tr>
<td>-21.0</td>
<td>-15.9</td>
<td>-0.2</td>
<td>-0.25</td>
</tr>
<tr>
<td>-23.0</td>
<td>-17.1</td>
<td>-0.9</td>
<td>-1</td>
</tr>
<tr>
<td>-25.0</td>
<td>-18.2</td>
<td>-1.6</td>
<td>-1.75</td>
</tr>
</tbody>
</table>

VI. Indications Extra-indications.

Provided the age of the patient and the other points to be immediately considered, are favourable, the indication for removing the lens with the object presented, the amount of Refractive in a case of high Myopia, consists in inability to wear correcting lenses. This inability, we have already seen, is very frequent in M. over 13 D., and consequently the patient is useless for any kind of work unless relieved to himself by his friend, unless he be relieved by surgical means.

What amount of Myopia is required to justify operative...
interference? - Finkeln between 1887 & 1890 needed the lens of 19 mg. ophic eyes of 13 D upwards. Others thought it too low, e.g., Schwigger said at the Heidelberg Congress 1877, that he had operated in five cases, his rule being that there must be at least 16 D myopia. At the 1893 Congress, Finkeln thought 14 to 15 D should be the lower limit for adults, 5 to 10 D in children of from 5 to 10 years of age, since in these the myopia is sure to increase, perhaps to 75 or 20 D by the time the patient is 20 or 30 years old, if left untreated. The reason for not operating below the above limits, was the fear of leaving such a high degree of hypermetropia, that unbeneficial would result; and cases below the above limits can usually be satisfied with glasses. Nevertheless, some operators adopted lower boundary, e.g., Vossius operated on a patient, â€œ20, 2/4, 0; + V = 7/5 at 5 m. About 12 weeks afterwards, there was + 5 D, V = 5/4 nearly. No doubt the operation was performed in this case on account of the inceptually bad vision, but it seems to be the lower limit at which the operation is justifiable, unless there be some other condition, e.g., opaquity of the lens, predisposed to alter the circumstances of the case. Vachâ" employer on two cases 0 - 11 D, each becoming hypermetropia
to the extent of 5 D. Pflüger has also had two similar cases, one becoming hypermetropia 5 D, the other 6 D. There are several other cases recorded of operation at this limit, and also a case by Keen, in which the lens had been removed for 11.10 D, hypermetropia 5 D resulting. Dr. Argyll Robertson 40 thinks there should be at least 12 D of myopia, this is the limit I should be inclined to fix.

Is there any upward limit in the amount of myopia, beyond which the operation is contra-indicated?—No. Here the reduction of the myopia only to the extent of about 10 dioptres, there would be no benefit to be expected from operating on an eye with much over 20 D, as the remaining myopia would still be so great.

luckily, as we have seen, the amount of reduction increases with the amount of original myopia—Thus Vossius operated on a law student; Myopia 30 D, the refraction in aphakia being 15 D of myopia, a reduction of 25.5 D. The reduction is not always so great, however; thus, in the highest degree of myopia, that has yet been recorded as operated upon, viz. a case of Schweigger's 33 D myopia, the refraction in aphakia was -13 D, a reduction of 20 D only. According to Beer's formula, we should expect a myopia of 4 D to remain in aphakia, such a
case. The probable explanation of so much myopia remaining in this particular individual, is that part of the original myopia was due to increased curvature of the Cornea.

What are the contraindications of this operation?

1. The ability to wear correcting glasses.
2. Extreme youth or extreme age.
3. Marked opacity of any of the media of the eye, other than the lens.

For very defective acuity of vision.

1. It is quite evident that where correcting glasses are well tolerated, it must be quite unjustifiable to subject a patient to the risk of an operation, which may possibly end in the loss of his eye, unless it should even be clearly demonstrated that the progress of the myopia is permanently checked by the operation, when it might be justifiable to operate in cases where the myopia is rapidly increasing.

2. Extreme youth - One cannot fix an exact limit in this; much will depend on particulars. It is

high myopia is uncommon during the first few years of life and as a rule, one would prefer to wait until a child was seven or eight years of age before operating, when it would be sensible enough to
answer question, to keep quiet during the after-treatment.

It was naturally thought by the earliest operators (Fukala, Vacher, others) that this was an operation suitable only for young patients, i.e. not much over 20 years of age. As time went on, however, it was found in practice, that it gave results, quite as satisfactory, in older patients. Pflüger in 1892 had operated on two patients over 50 years of age, Thien in 1893 on a man aged 50 and another of 41, Valude on a patient of 35. Schweigger had also performed it on a patient aged 80. At the Heidelberg Congress 1895 v. Hoppel v. Salter reported cases in which it had been done on patients up to 64 years of age, with satisfactory results. They stated that the lens, in high myopia, does not undergo the usual sclerosis, attendant upon old age. There would be a considerable difference in the effect of needing such a lens that found under ordinary circumstances.

Marked opacity of any of the media other than the lens. This extreme indication is evident enough. It would be of very little use to retain the lens, in the presence of such a condition, since the sight would not be usefully improved. Opacity of the lens, of course, would
be an indication for the operation.

Very defective vision. The usual cause of this in high myopia, consists in marked choroidal changes in the fundus, especially in the macular region; it may be either spots of choroiditis and atrophy, or a very large elliptical posterior. It is considered such changes as contraindicating the operation, and will not operate on patients who cannot read T, or at any rate to fluently, who has not 15/60 at a distance. But some results consider that sufficiently good results can be obtained, even in the presence of the above compromising conditions, to justify the operation. Thus D. Hoppel stated that he did not consider choroidal complications contra-indicated this treatment. At the Edinburgh Congress, Pflüger said "I do not look upon choroidal changes as a contra-indication; cases of 15/6 without posterior polar choroiditis are so uncommon, and the operation, if wholly limited to non-complicated cases, will scarcely be indicated at all. That good results, comparatively, can be obtained in very compromising cases, was shown by Cross, who had treated nine cases, in 6 of which V of 6 could not be obtained with any lens. Two with Myop of 15 6, corrected, for 5/24 and 5/60 respectively,
and in the other - 22.5 gave 5. One eye (1/25) had a sound fundus, except for a large posterior staphyloma. In all the others there existed more or less damage to the choroid near the Macula. He thought the results were satisfactory enough to make him a strong advocate for operation in high myopia. At the same time, most operators would consider long before they touched a case with such change in the choroid, more particularly at the Macula, since vision could not be much improved in such, and no doubt the risk of hystoptasia from the retinal vessels or detachment of the retina increases with the amount of change at the back of the eye. Defective vision due to an atrophic condition of the optic nerve would also contraindicate operation.

VII - Should one or both eyes be operated upon?

In 1890, Archibald H. J. H. P. recommented that the operation should be carried out on both eyes, but he was opposed by others, chiefly Schweiger, Pflüger, and Schröder. These felt it thought that the operated eye could afterwards be used for distant vision if the unoperated for near. In some cases, this can be done, but, as a rule, for near
Vision, the patient prefers to use the operated eye.

Thus, at the Edinburgh Congress, 1894, Pfluger said: "I completely agree with Herr Thiers that near work, generally speaking, is preferably carried out by the operated eye, with the aid of a weak convex glass, than with the strongly myopic eye." In the monocular operation, we sometimes require to shut out the unoperated eye by a dark glass, to avoid diplopia or asthenopia. For this reason, in these cases, the operation should be carried out on both eyes. Another important point is that binocular vision can only be restored by the double operation. Where there is no expectation of restoring binocular vision, and where the patient can use the non-operated eye for near objects without trouble, then the second eye should not be operated upon - it would be unnecessary.

VIII - Methods of Operation.

There are two distinct methods of removing the lens in high Myopia - the one might be called the "French method" or "Vacher's operation" consist in direct linear extraction of the crystalline lens; the other is the "German method" or "Todt's operation", in which the needle is passed on
several occasions, and subsequently removed through
an incision in the Cornea, if necessary.

There is little to be said of Becker's method, since
it is merely the ordinary bicanal extraction, as used for
cataracts in young persons, followed, if need be,
by division of any remaining opaque capsule.

Fukuda, however, remaining opalescent capsule,
there is greater danger of retention of a de-
tachment of Retina occurring if this method is
compared with his, as he believes the full glazing
to more sudden complete.

Fukuda's method is the one used by the great majority
of surgeons. At first he always, when he could get
permission, carried out a preliminary biode-
scopy. This was soon shown to be a useless preca-
cution and was consequently given up. Any con-
sequent enlargement can be speedily and completely reduced
by opening the anterior chamber, allowing the
lens matter to escape.

Before operating the pupil is well-dilated by Atropine.

The lens is then well-stirred with a suitable instru-
ment. At first, Fukuda used to make only a small
crosscut in the lens capsule, so as not reproduce
his great swelling. Their showed that so much
centrum was not required. He used a Graefe's
knife for this part of the operation, dividing the
whole thickness of the lens as far back as the posterior capsule. If swelling did not follow quickly enough, a similar cut was made in the lens substance, at right angles to the first. He claimed that this procedure shortened the duration of treatment very considerably. There was but little chance of any "after-opacity", as the vitreous pushed forward the few little flaps of post-capsule, thus leaving a clear centre. At the Edinburgh Congress 1884, Pfizer said he had tried this particular method in many cases, but he had given it up, on account of the difficulty in the subsequent removal of the lens matter due to the tendency of the vitreous to prolapse. There seems to be no need of such a drastic procedure as Thiers, as by thorough needling followed by subsequent attraction of the lens substance, treatment does not last longer than two months. I think a cutting needle, such as is used for dividing opaque capsule, might be used with advantage to make a large opening in the anterior capsule, instead of the ordinary dissecting needle. In some few cases, the lens matter has been absorbed so quickly, after a few needling, that no further operation was required—thus Vorstius on Oct. 26th 1894, dissected the anterior lens capsule.
in a patient, Aug. 21, and repeated it on Nov. 27.
This was all that was required. On Jan. 30th, 1895.
There was an absolutely black pupil.
As a rule, either to relieve tension or signs of iritis
of the eye, or to shorten the duration of treatment, it
becomes necessary to make a corneal incision, plus
a hole made in ordinary linear extraction, remove
the lens matter from the aqueous chamber. Some
vent to make the opening above, others below (Shaw),
whilst others make it in such a position that the flat
turning of the Cornea meridian, at right angles to the
axis of the wound, produced by the contraction of the
latter during healing, will reduce or overcome any
pre-existing Corneal Astigmatism (Regis). To
do this, the curvature of the Cornea must previously be
carefully estimated by an Aplha-Keratometer. The direc
tion of the principal axes of Astigmatism noted.
Ferguson prefers removing the lens matter by section.
It may be necessary to repeat the opening into the
anterior chamber, or to follow it by subsequent
needlings, if there be much lens material or capsul
left.
Should it be inconvenient to open the aqueous cham-
ber at once for signs of iritis or
puss of lens in, Atropin may be instilled temporarily,
since Kegelius has affirmed, that quite contrary to what we should have expected, Atropin is quickly useful relief. It is a good plan, in fact, to order Atropin drops, twice a day, if all cases, after the operation, as this keeps the Iris, as far as possible, out of the way of the broken up lens material, prevents any adhesions & lessens the chance of any Iritis or Cyclitis occurring.

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TX: We have seen the benefits arising from the operation; we must now inquire if these are obtained without danger, or if not, what are the risks incurred? We may at once answer the first question in the negative. There are, of course, the same dangers attaching to the operation as in needlings or Cataract extractions in ordinary eyes; some authors think the risk is considerably greater in highly myopic eyes, as they consider such eyes do not tolerate any operative interference, as well as an emmetropic eye. I think that, seeing the large number of cases that have now been published the rarity of any untoward result, we may safely say that such eyes tolerate the operation under consideration extremely well. At the end of the discussion on this subject, at least
The dangers or complications of this operation are —
1. Trichiasis or Cyclitis, usually associated with rise of tension.
2. Suppurative Inflammation, probably passing into pars planitis or loss of the eye.
3. Intracocular hemorrhage.

The first named complications (Trichiasis or Cyclitis) are the only ones at all frequently met with. They are rare, if the case be properly watched, so that the lens substance can be promptly removed through a corneal incision, or the first signs of irritation (pain, lacrimation, etc.) Suppurative Inflammation occurring within the eye, most often is considered due to the introduction of septic material either at the time of the operation or at any time before the corneal wound has closed. It can, therefore, be avoided by careful sterilization of the instruments used, by rendering the conjunc-
just one aseptic prior to operation (by washing it out with a solution of copper sulphate), and maintaining it sterile by the application of aseptic or anti-septic dressings. Nevertheless, cases of septic inflammation have been recorded, e.g. Lang 34 said that he had operated on two cases, one of which suppurative inflammation followed resection of the optic capsule, resulting in loss of sight. Moreover Marshall recorded a similar case. In the second case of both these operations, detachment of retina occurred. It is curious that such misfortunes should have attended the earliest attempts made by English ophthalmic surgeons, when we look through the large number of cases, reported by Continental authorities, e.g. Pfützer, Schweigger, Tschalke or and find hardly a case of the eye being lost through suppuration.

As regards the danger of intravascular haemorrhage, although dwelt strongly upon by the opponents of the operation, e.g. Landolt (Heidelberg Cong. 1891) and Rählmann (Heid. Cong. 1893), I do not believe that a single case of its having occurred, has been reported.

Lastly, we have to consider the possibility of detachment of the retina occurring. This possibility
has been used as one of the main arguments against the operative treatment of myopia. We all know that detachment of Retina is more common in high myopia than in other refractive conditions. Moore* found that in 5,631 cases of myopia with all degrees of retino-chloroisis in posterior detachment of Retina occurred on one side in 1,284 cases or 23.8%, and on both sides in 111 cases. Seeing the great frequency of this complication, therefore, in high myopia, we should not be surprised to find it occasionally following any operative procedure on the eye.

On looking through the various reports on this subject, we see that it has happened sometimes, and occasionally those opposed to the operation have seized upon such cases to say "poor he, ergo people lose!" But how do they account for cases, in which, soon after the operation, detachment of Retina has occurred in the non-operated eye, with or without detachment in the operated eye? Is it through "sympathy" or is it "reflex"?

We shall now mention some cases of detachment of the Retina, which have been reported as coincident with this operation. At the Heidelberg Congress 1899, Valdrie cited the case of a child, act. 10, c. 15.6 of 

Myopia, from which he had extracted the crystalline body, on the one side performing a direct extraction, on the other a discussion, followed by extraction. Two months after the direct extraction, a total detachment of Retina occurred in that eye. Fukada said this was an illustration of the greater chance of direct extraction as compared with extraction subsequent to discussion. The fallacy of this statement, however, was shown at the Reid Soc., 1828, when Valere reported that his patient was in imminent danger of losing the second eye from the same accident. At the Edinburgh Congress, 1874, there had been two cases of Retinal detachment follow the operative treatment of high Myopia, once in a man of 43, with extensive choroidal changes and vitreous sponginess, and once in a woman, aged 28, who had been confined since the operation she contracted Syphilis. At the same meeting, McPherson of Glasgow, reported another case. At the Ophth. Soc., Jan., 1875, Long said he had operated on two cases of myopia, in one of which detachment of Retina followed in the operated eye three months afterwards; in some months subsequently in the non-operated eye. Doctorne Marshall had also tried the operation in two cases, in one of which
retinal detachment followed.

At the Heidelberg Congress, 1875, Lattler had observed 4 instances of this accident out of 68 cases, but he was of the opinion that it was not the result of the operation, unless it were due to the traction exerted by the scar on the vitreous, which, in his cases, prolapsed and had to be snipped off. On the other hand, he had seen two cases, in which detachment had followed in the non-operated eye, the operated eye being to remaining well.

Vacher also tells of a patient with 1800 thymopia, upon whose left eye he operated. This eye did well, but three years afterwards, the right eye showed a large detachment of retina, which had cause in "sans essence, sans traumatisme." He has also seen cases of detachment in myopic patients, who had refused operation. Supposing they had been operated upon, would the detachment have occurred? It is impossible to say at present. One thing is certain, viz. that if it had, many would have been inclined to ascribe the detachment to the operation.

When we think of the large number of cases (over 1000) that have been operated upon, and when we think of the very small proportion in which detachment of
Retina has occurred (Schweiger & Pfüger have each
done this operation more than 100 times, & I believe has
not reported a case of detachment) when we consider
that, in several cases, it has occurred not in the
operated, but in the unoperated eye, we must not only
feel convinced that detachment of retina following
removal of the lens for high Myopia, is little, if
anything, more than an accidental occurrence,
but that there may be some truth in Vacher's belief
that this operation "avait une action préventive
au décolllement de la rétine."

To sum up, the operative treatment of high My-
pia seems to have given satisfactory results to nearly
every oculist who has tried it; there is great reduction in the
amount of myopia; important improvement in visual power,
rendering the patient again fit for work; in some cases, the
progress of the myopia is checked entirely or partially, & in many
cases the patient no longer requires to wear glasses. As
regards the tendency to produce detachment of retina, au-
thorities are somewhat divided, some believing that the operation
is actually prophylactic against it, others that
there is a somewhat increased tendency
after this treatment. We can state nothing
and that is, that there is at any rate no
great exciting influence towards this misfortune. On the whole, therefore, Arakon's operation appears to be an important addition to ocular therapeutics, likely to markedly benefit many patients, who formerly would have been in a helpless condition, on account of their visual incapacity.