the older age-groups (in the City of Birmingham survey there were 44,000 women, as opposed to 24,800 men, over the age of 70 years). Both of these factors would operate to produce more ruptures of the heart in women than in men.

Although we cannot explain the increased risk of rupture in older patients, we can get some information from the hospital series about the circumstances in which rupture occurs. The maximal risk is in old patients with electrocardiographic evidence of transmural infarction, the first 24 hours after the infarction being particularly critical. There is no evidence to support the view that the patients who rupture are the ones whose blood-pressure remains high after the infarction. The rupture did not relate to physical activity, for most of our patients were in bed, and nearly half were asleep, at the time of rupture.

Summary

215 cases of rupture of the heart after myocardial infarction are reported. The sex ratio (96 male; 119 female) differs significantly from that for myocardial infarction.

This is due to the increasing risk of rupture in old patients and the tendency for women to develop infarcts later in life than men.

The risk of rupture is maximal in the first 24 hours after infarction, and there does not appear to be any correlation with physical activity, digitalis or anti-coagulant treatment, or high blood-pressure levels after infarction.

We are grateful to the Records Departments of the United Oxford and the United Birmingham Hospitals for their help with the case-notes, and we are particularly indebted to Mr. G. Billington, H.M. Coroner for the City of Birmingham, for allowing us to make use of his records.

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The publication *Russian-English Scientific and Technical Dictionaries* has been prepared for the National Science Foundation, U.S.A., by Professor A. F. Hubbell. The main chapters are: Types of Interlingual Dictionaries; the Plan of Existing Russian-English Dictionaries and Recommendations for the Improvement of Future Works; the Organization of Lexicographical Projects; Survey of Needs in Particular Fields (Mathematics, Physics, Chemistry, Earth Science, Meteorology, Cartography and Related Fields, Aviation and Aeronautical Sciences, Space Sciences, Military and Naval Sciences and Technologies, Medicine and Medical Sciences, Life Sciences, Miscellaneous Technologies and Engineering Specialties). Copies of this 20-page report may be obtained at 40 cents each (U.S. stamps or Unesco coupons) from Professor A. F. Hubbell, Gallatin House, New York University, New York 3, N.Y., U.S.A.

ALPHA-CHYMOTRYPSIN IN CATARACT SURGERY*

BY

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In a preliminary communication to the Royal Academy of Medicine of Barcelona in April, 1958, Joaquín Barraquer first described the use in ophthalmic surgery of alpha-chymotrypsin, a proteolytic enzyme, to weaken the fibres of the suspensory ligament of the lens and consequently facilitate its removal.

This is undoubtedly a most significant advance in the surgery of cataract, and during the following year publications from every major country testified to the veracity of his findings. There is no doubt that in the living human eye alpha-chymotrypsin, injected into the region of the zonule of the lens, destroys or weakens this structure so that little mechanical force is required to remove the lens.

Possible Bad Effects

The possibility that the use of the enzyme might have bad effects, however, caused equal discussion, which has not led to the same universal agreement.

Firstly, animal and *in vitro* experiments seem to suggest that alpha-chymotrypsin has an effect on other tissues of the eye than the zonule. Salmony (1959) studied the biochemical action of the enzyme on the aqueous, the lens homogenates, and the vitreous of the ox, and on the lens and aqueous of the rabbit, and demonstrated that a fairly rapid breakdown of proteins in all these tissues occurs when incubated with alpha-chymotrypsin. This seems to prove that the effect of the enzyme is not restricted specifically to the zonule but is capable of attacking other structures, such as the vitreous. Appelmans, Michiels, de Backer, and Alaerts (1959) injected alpha-chymotrypsin solution into rabbit corneae and instilled drops containing the enzyme on to corneae denuded of epithelium, and showed that there was a harmful effect on the parenchyma of the cornea. Bégué and Waksman (1959), using rabbits' eyes, sought to prove that the enzyme affects only the cement substance between zonule and lens capsule. Bedrossian (1959), in his experiments, seemed to prove that there is no ill effect on wound-healing.

Secondly, discussion regarding the clinical findings relating to possible side-effects of the use of alpha-chymotrypsin in the living eye has been even more confused.

The following are the main effects that have been suggested.

1. *Delayed Healing of Wound*.—Barraquer (1959) himself, in his survey of 297 cases, described an increased incidence of delayed re-formation of the anterior chamber. Weekers, Lavergne, and Stassart-Hourlay (1959) also described this complication, but otherwise it does not seem to have troubled many surgeons.

*The work was carried out in connexion with the South-west Metropolitan Regional Hospital Board's Research Competition, 1959, for which it received the principal award.

2. *The Cornea*.—At clinical meetings in the United Kingdom during 1959 much discussion centred around the possibility of an increase of striate keratitis. However, there was no general agreement about the incidence of this complication in cataract extraction with or without the enzyme. Ainslie (1959) pointed out that the use of the mechanical erisophake might be the cause of increased striate keratitis. Deposition of iridian pigment on the back of the cornea was described by Piers (1959a) and others. Hill (1959) described marked vascularization of the cornea after extraction with alpha-chymotrypsin, but this report relates to a single case only.

3. *The Vitreous*.—Although the most dangerous possibility would seem to be damage to the vitreous there has been little published study of this tissue after extraction using the enzyme. Norbis and Malbran (1958) and Walser (1959) mentioned damage to the anterior hyaloid membrane, but these findings were not conclusive.

The continued plea of many responsible observers in this country has been for caution in the use of this method of cataract extraction until clinical observations over a reasonably long period are available. This study was undertaken to help fulfil this need.

Scope of Present Study

During June to December, 1958, 65 cataracts were operated upon by us, working jointly as surgeon and assistant and using alpha-chymotrypsin in each case. Cases were not selected. We have undertaken an assessment of the complications, operative and post-operative, and the results of these cases; and a careful slit-lamp study of the cases during 1959.

The technique used in the series was as described by Piers (1959b).

Operative Complications

The number of cases operated on was 65; vitreous loss occurred in 1, and rupture of the capsule during extraction in 4.

In the case of vitreous loss the vitreous was fluid and the loss occurred during the Graefe knife section. The patient had a history of severe injury to the eye during the 1914–18 war. In view of the high percentage of complicated cases in the series, this seemed at the time, and still does in retrospect, a very satisfactory and worry-free series of cases.

Immediate Post-operative Complications

Among the 65 cases, prolapse of iris occurred in 1, mild striate keratitis in 4, hyphaema in 7, iritis in 2, and severe keratitis in 1. Healing was delayed in one case.

Striate Keratitis.—This was regarded as an abnormal complication only if it was present for several days after operation. Occasional very slight haziness of the cornea at the time of first dressing, too indefinite to localize in any layer of the cornea, was not considered. The four cases in which definite striate keratitis occurred would seem to be a normal or low percentage of this complication. They all resolved without any effect upon the vision. Corneal oedema appearing at a later stage is considered in the next stage of the study.

Hyphaema.—There were seven cases of hyphaema, excluding cases in which there were small traces at the time of the first dressing. In three cases hyphaema was caused by external trauma several days after operation. In two others it was associated with diabetes.

Iritis.—There were two cases with an iritis lasting about three to four weeks post-operatively.

Delayed Healing.—This case was possibly due to post-operative trauma. From the clinical appearances it seemed very unlikely that the complication bore any relation to the use of alpha-chymotrypsin.

Severe Keratitis.—This case is considered later in the study.

Visual Results

It is of interest that 24 patients—that is, 37%—suffered either from other pathological conditions in the operated eye or from diabetes mellitus.

The visual acuity in 63 patients after a post-operative period of one year was: 6/6 in 36, 6/9 in 8, 6/12 in 4, 6/18 in 5, 6/24 in 2, 6/60 in 4, and less than 6/60 in 4. Two were not tested (died before minimum period).

Of the 15 patients with a final visual acuity of 6/18 or worse, in nine it was directly attributable to retinal disease present prior to the extraction, in two corneal conditions existing previously, in two to post-operative trauma by the patient, in one to severe bullous keratitis, and in another to amblyopia ex anopsia.

Slit-lamp Examination

In order to determine if there were any complications in this series of extractions that could be attributed to the use of alpha-chymotrypsin, the cases were examined several times with the Zeiss corneal microscope during 1959. At the same time we examined a number of cases of uncomplicated intracapsular extraction, all of which had a corrected vision of 6/6 and which had been operated upon during the previous two years.

Corneal Oedema and Resultant Opacities

Apart from transient striate keratitis, which has already been considered, there were cases of isolated patches of corneal oedema. This finding is, of course, a common one in cataract surgery with known causes, into which most of our cases fell. The main causes of persistent corneal oedema after cataract extraction, apart from the possibility of alpha-chymotrypsin damaging the endothelium, may be summarized as:

1. *Damage to the Endothelium and Descemet's Membrane*.—Unless care is taken it is easy to damage the under-surface of the cornea with instruments, and especially with the erisophake on account of its relative size. Kirby (1955) and McDonald (1957) have stressed this danger. Descemet's membrane may be torn, allowing aqueous humour to penetrate into the corneal stroma.

2. *Vitreo-corneal or Irido-corneal Contact*.—Small anterior adhesions of the peripheral part of the iris to the cornea in the vicinity of the section are sometimes seen with the slit-lamp after cataract extraction. A proportion of the synechiae develop corneal oedema in the overlying area. If an intact anterior hyaloid membrane herniates through the pupil sufficiently to touch the posterior surface of the cornea, corneal oedema may result. Chandler (1954) has stated that if the intact hyaloid membrane adheres to the posterior corneal surface, corneal oedema almost invariably results, and this may be permanent. Sometimes one sees with the slit-lamp strands of vitreous projecting forwards into the anterior chamber and perhaps touching the posterior surface of the cornea, but this does not seem to cause any corneal disturbance.

3. *Pre-existing Endothelial Dystrophy*.—The worst cases of persistent corneal oedema occur in cases of endothelial dystrophy. This has been stressed by many authors (Chandler, 1954; McLean, 1954).

The safety associated with the low intraocular pressure of modern anaesthesia encourages the surgeon to lift the cornea and perform intraocular manoeuvres

under direct vision. In the early stages of using the mechanical erisophake we were in the habit of opening the section widely to introduce the instrument; we think that this was the main reason why we had several cases of striate keratitis and corneal oedema in the present series. Since recognizing this danger we have been careful to lift the cornea only enough to allow the introduction of the erisophake; in the later part of the present series, and during the succeeding year, this was the technique we adopted.

Another factor in the production of striate keratitis may have been the incidental damage to the endothelium when the cannula was introduced into the lower part of the eye in order to inject alpha-chymotrypsin behind the lower part of the iris. We now inject alpha-chymotrypsin only through the iridotomy above.

During the present series we thought it possible that alpha-chymotrypsin might alter the permeability of the corneal endothelium in some way and cause an increased incidence of striate keratitis and corneal oedema. Since changing our technique in the ways described above, however, the incidence of striate keratitis has definitely been lowered, and we have had no serious case of corneal oedema.

During the past year we have had no reason to think that alpha-chymotrypsin was a factor in the production of striate keratitis or corneal oedema. Seven out of 65 cases had persistent corneal oedema and one had vision affected by corneal oedema. In two cases an anterior synechia of the upper part of the iris seems to have been responsible for the oedema. Three cases were probably due to tears in Descemet's membrane. In one case there was oedema for one month which cleared up completely: vision is 6/6. No tears in Descemet's membrane were seen. There was one case of so-called bullous keratitis—persistent marked corneal oedema. The exact cause of this has not been elicited.

Pigment Dispersal

1. *Posterior Corneal Surface*.—Though we regarded the presence of pigment on the posterior corneal surface as a complication of the operation it had no effect on the visual acuity. The findings, in 56 cases, were as follows.

None or very slight pigment	28 (50%) cases
Moderate pigment stippling	20 (36%) "
Marked pigment stippling	8 (14%) "

2. *Pigment Granules on the Iris* (54 cases).—Several of the cases showed a moderate to marked scattering of pigment over the front of the iris.

No pigment	35 (65%) cases
Moderate amount of pigment	14 (26%) "
Marked amount of pigment	5 (9%) "

3. *Atrophy of the Iris* (53 Cases).—As before, we divided our cases into three arbitrary groups, and the results were as follows:

No iris atrophy	22 (42%) cases
Moderate iris atrophy	24 (45%) "
Marked iris atrophy	7 (13%) "

4. *Pigment Granules in the Anterior Vitreous* (52 Cases).—62% of our cases had a moderate or marked amount of pigment in the anterior part of the vitreous. Sometimes the pigment was seen scattered over the front of the anterior hyaloid membrane, but, in addition, pigment granules were sometimes dispersed in the anterior layers of the vitreous.

No pigment in vitreous	20 (38%) cases
Moderate amount of pigment	26 (50%) "
Marked amount of pigment	6 (12%) "

General Consideration of the Pigment Dispersal

We thus found that in this series pigment granules were scattered over the posterior surface of the cornea in 50%, on the front of the iris in 35%, and in the anterior layers of the vitreous in 62% of the cases. 58% of our cases showed areas of iris atrophy, so presumably the pigment had come from these areas. Kara (1959) also described excess pigment deposit on the corneal endothelium and in the vitreous after cataract extraction with alpha-chymotrypsin. In patients who had been operated on without using alpha-chymotrypsin we found that a similar appearance was sometimes seen, but it was not so frequent.

It is possible that our technique of introducing the cannula behind this iris in order to inject the alpha-chymotrypsin into the posterior chamber was the reason for the pigment dispersal, as the cannula must necessarily rub against the back of the iris during this manoeuvre.

There was no increase in the pigment dispersal during the year of the review.

No definite conclusions can be drawn from this series of cases. All we would say is that from our experience it seems possible that alpha-chymotrypsin is a factor in the production of pigment dispersal throughout the anterior part of the eye but that no ill effects to the eye result from it.

Size and Mobility of the Pupil in 46 Cases

Pupil Size	No. of Cases	Mobility of Pupil	No. of Cases
2 mm.	8 (17%)	Immobile	4 (9%)
3 "	24 (52%)	Slightly mobile	28 (61%)
4 "	10 (22%)	Mobile	14 (30%)
5 "	4 (9%)		

It seems likely that in many cases there are small adhesions between the iris and the anterior hyaloid membrane which are not visible with the slit-lamp; they prevent full mobility of the pupil. Another interesting finding is that if there is a herniation of the anterior hyaloid membrane through the pupil, this becomes more flattened when the pupil is dilated with a mydriatic. This effect is probably also due to these adhesions between iris and vitreous.

The Vitreous Face

Surrounding the vitreous is the so-called hyaloid membrane, the exact nature of which is unknown. Duke-Elder (1940) considers that it is merely a surface condensation of the fibrillar elements of the gel. Cowan and Fry (1932) produced evidence to show that in its anterior portion, at any rate, the hyaloid membrane is a non-nuclear, structureless, uniformly staining membrane.

In our case we examined the anterior hyaloid membrane with two questions in mind: (i) whether the vitreous face was flat, or protruding into the anterior chamber; and (ii) whether the anterior hyaloid membrane was intact or had holes or rents in its surface.

After cataract extraction the anterior surface of the intact vitreous face behaves as if it was limited in front by a definite membrane. Even with the highest magnification of the Zeiss corneal microscope, however, no actual membrane can be seen. The position and contour of the anterior hyaloid membrane is judged by means of pigment granules on its surface and slight opacities of the vitreous itself. If these are absent it is difficult and sometimes impossible to judge the position of the anterior hyaloid membrane accurately.

Protrusion of the Vitreous Face

It is well recognized that herniation of the anterior hyaloid membrane is common after cataract extraction (Berliner, 1949; Hilding, 1954). Leahey (1951) made a survey of 100 unselected intracapsular extractions and found that 39% showed a herniation: in 13% the anterior hyaloid membrane was touching the cornea, though in most of these the contact was merely a peripheral one at the top of the complete-iridectomy area. Irvine (1953) found that only 54% of post-cataract cases had a flat and intact vitreous face.

These figures agree fairly closely with our own in this series. Our findings in 57 cases were:

Flat or slightly convex	31 (54%) cases
Moderate protrusion	13 (23%) "
Marked protrusion	13 (23%) "

In no case in the series was an intact vitreous face touching the back of the cornea.

The surface of a protruding vitreous face is often lightly speckled with pigment granules. Sometimes the whole protrusion is quite mobile. Undoubtedly, trauma during the operation is more likely to produce such protrusions, but trauma is not necessary for their occurrence, and even after the most satisfactory and easy extraction it is not uncommon to find a herniation of vitreous face. Such vitreous protrusions become flatter in time. This occurs gradually over several months. We noted this flattening of a vitreous bulge in seven of our cases. One case was noted as having a marked protrusion: five months later the vitreous face was flat.

Another interesting finding was that in some cases the anterior hyaloid membrane has a double contour.

Condition of the Anterior Hyaloid Membrane

Previous observers are also agreed that tears and holes in the anterior hyaloid are often seen after intracapsular extraction, though exact percentages are seldom quoted. Leahey (1951) found such tears in 22% of cases; Irvine (1953) noted rupture of the vitreous face at a later stage in 23% of cases. Our findings (57 cases) were:

Intact	36 (63%) cases
One or two small holes with strands of vitreous in anterior chamber	17 (30%) "
Marked rents	4 (7%) "

In most cases there are one or two small holes: from these, loose strands and fibrils of vitreous project forwards into the anterior chamber. Sometimes numerous fine processes seem to spring from almost the whole of the anterior surface of the hyaloid. A large circular hole in the hyaloid membrane may also be seen. Through such a hole the vitreous herniates and forms a second condensation a short distance in front of the hyaloid membrane.

In one case only was there free vitreous in the anterior chamber without any demonstrable hyaloid membrane. In four instances small rents were noted which were later found to have disappeared. In two instances holes appeared in a previously intact vitreous face, as described by Irvine (1953) and Arruga (1956).

In those cases we examined in which alpha-chymotrypsin had not been used, the incidence of vitreous herniation and tears was almost the same as in the alpha-chymotrypsin series.

We do not think that the incidence of tears in the anterior hyaloid in this series is excessive, and we have no reason to believe that alpha-chymotrypsin helped to produce them.

Opacities in the Vitreous

Vitreous opacities occurred in 52 cases, as follows:

Small amount	15 (29%) cases
Moderate amount	26 (50%) "
Marked amount	11 (21%) "

In many cases wavy vertical lines, irregular tufts, and spots of opacity could be seen. These were mostly in the anterior part of the vitreous, which became more clear as one focused further back. The appearance is similar to that seen in myopia and old age. In only one instance did these opacities cause any interference with vision. It would seem that the trauma inflicted on the eye during a cataract operation leads to a degeneration of the vitreous with disruption of the normal framework and the appearance of opacities.

When we compared these cases with those in which alpha-chymotrypsin was not used there seemed to be a slightly higher incidence of vitreous opacities in the alpha-chymotrypsin group. We did not feel that the difference in this series of cases was too small to warrant any definite conclusions being drawn.

There appeared to be no increase over the period of the study in the amount of the vitreous opacities.

Posterior Detachment of the Vitreous

In both series of cases we found a high incidence of posterior detachment of the vitreous. We also noted the appearance of large optically empty clefts in the vitreous in several cases. Sometimes two or three of these clefts were present. We would postulate that when the lens is removed the anterior vitreous fills in the defect with the production of clefts in the vitreous itself or of a posterior vitreous detachment, or both.

Other observers have noted a high incidence of posterior vitreous detachment in older age-groups. Teng and Chi (1957) found a 44% incidence in the 50-80 age-group. Pischel (1953) found a 58% incidence in patients over 50 years. We think that there is an increased incidence of posterior vitreous detachment after intracapsular cataract extraction, but do not associate it with alpha-chymotrypsin.

Conclusions

We have no doubt that alpha-chymotrypsin weakens or destroys the zonule and makes cataract extraction an easier procedure.

There were no operative complications in the series that could be attributed to alpha-chymotrypsin.

The visual results compare favourably with our cases before the use of the enzyme and with the previously published figures of other authors not using alpha-chymotrypsin.

Only one severe post-operative reaction—the case of bullous keratitis—was not well explained.

There was some liberation of pigment from the posterior layer of the iris in about 50% of cases. This is probably mainly due to the mechanical effects of operative intervention. It does not seem to cause any harmful effect in the eye. We feel that it is more likely

to occur when using alpha-chymotrypsin but that this increase may be due to the slight increase in mechanical intervention.

There seemed to be a slightly higher percentage of cases showing increased opacities in the vitreous in this series than in our previous cases. We feel that the difference was not great enough for us to draw a definite conclusion. There was no increase in the amount of the opacities in any case during the follow-up period.

In our series the vitreous face was carefully inspected over a period of a year. The appearances were compared with earlier cases of our own and with the descriptions and statistics of previous authors relating to uncomplicated intracapsular extractions without the enzyme.

We believe that there is no greater tendency either to bulging forward of the vitreous face or to the appearance of rents and tears in the anterior hyaloid membrane when alpha-chymotrypsin is used.

There was no tendency towards deterioration in the vitreous face during the 12 months of the study.

Our thanks are due to the nursing and clerical staff of the Croydon Eye Unit for their assistance, and in particular to Mrs. S. Tant, medical secretary.

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An exhibition of 1,200 British books on science, technology, medicine, and surgery has been assembled by the British Council for touring Japan early next year. This first large exhibition of its kind sent to Japan by the Council has been organized in collaboration with the Japanese Publishers' Association for Cultural Exchange. It is planned that the books will be exhibited first at the main universities of Tokyo and then in the principal university cities of Japan. There will be 33 sections in the exhibition covering all the main branches of science, technology, medicine, and surgery, and a 94-page catalogue listing each book has been prepared.

AETIOLOGY, DIAGNOSIS, AND TREATMENT OF PARAESTHESIAE IN THE HANDS*

BY

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This paper is primarily concerned with the syndrome of the carpal tunnel and the disturbance of median-nerve function arising therefrom. The clinical features, aetiology, diagnosis, and treatment of this condition are considered in relation to 327 patients under my care in the years 1948–58.

The term "acroparaesthesia" was introduced by Schultze (1893) to apply to a condition in which pain and tingling in the hands were the prominent features and in which physical signs were scanty or lacking entirely. Affecting women mainly, it tended to appear in middle life and most commonly between the ages of 35 and 55. In the next 50 years various theories were advanced to explain the symptoms of this disorder and varying therapeutic measures were advised—some rational, some bizarre—all having in common their relative inefficacy in relieving the symptoms of which the patients complained.

There are, of course, numerous conditions in which paraesthesiae may occur in the fingers, hands, and arms, usually as an incidental feature in association with other symptoms, and it was probably the recognition of the fact that paraesthesiae may at times result from the presence of a cervical rib that directed attention away from a possible distal mechanism.

Kinnier Wilson (1913) regarded the condition as invariably arising at the thoracic outlet and described two clinically distinct types—(a) that in which local wasting of the thenar eminence is pronounced, with paraesthesiae on the radial side of the hand, and (b) that in which generalized atrophy of the intrinsic hand muscles leads to a claw hand. He also described trophic and vasomotor changes and mentions the occurrence of gangrene of the index finger. Sargent (1921) reviewed 95 patients under his care in whom pain, paraesthesiae, disorders of circulation, affections of cutaneous and other forms of sensation, weakness, and wasting occurred in varying combinations. He mentioned the quite frequent absence of visible wasting in the muscles. Of 32 patients with muscle-wasting in the hands, 12 presented with wasting in the thenar muscles, and it is significant that operation on the neck often failed to relieve these latter patients.

Walshe, Jackson, and Wyburn-Mason (1944) and Walshe (1951) describe various mechanisms in relation to cervical rib, the first rib, the subclavian artery, and the clavicle, by which they consider acroparaesthesia may be produced. It is suggested that the localized wasting of thenar muscles may be due to a constant relationship of the fasciculi in the outer head of the median nerve to the subclavian artery—an observation that becomes untenable in the light of the work of Sunderland (1945) (see below). The same writers suggest that dilatation of the subclavian artery, with or without thrombosis and distal emboli, may play a part

*This study was carried out for, and was successful in, the South-west Metropolitan Regional Hospital Board's competition for research reports, 1959.