COMMUNICATIONS

INTRACAPSULAR CATARACT EXTRACTION USING ALPHA-CHYMO-TRYPSIN*

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ALPHA-CHYMO-TRYPSIN (A.C.T.) is an enzyme with fibrinolytic and proteolytic properties which is prepared from bovine pancreas. It was discovered by Dr. Joaquin Barraquer in 1957 that the substance had a selective solvent action on the zonule supporting the lens. After extensive animal and *post-mortem* experiments he applied the discovery to the living human eye with important results. He found that the enzyme, when introduced into the anterior chamber after the corneal section had been made, caused a complete lysis of the zonule in approximately 3 minutes at body temperature. Owing to the kindness of Dr. Barraquer in sending supplies of the material it has been possible to use A.C.T. in cataract operations at this hospital since April, 1958, and a consecutive series of 122 cases is here presented.

Material

Three preparations of enzyme were used:

- (1) *Chymotrase (Quimotrase)*, the original Spanish product, from the Barcelona firm of PEVYA.
- (2) *Zonulysin*, manufactured by Stervac of Capetown and distributed by Maw in Great Britain.
- (3) *Chymarzon*, manufactured and distributed by Armour Laboratories.

One series (J.E.H.C.) included cases in which all three enzymes were given a clinical trial. The other series (H.M.S.) was restricted to Chymotrase alone. All the preparations have been assayed by their manufacturers and are used at 1 in 5000 dilution, designed to give an approximately equal strength of proteolytic action. The Chymotrase solution loses 20 per cent. of its stability at room temperature after 4 hours, but if kept at 5° C. retains 60 per cent. stability up to a month. In practice, in this unit, a fresh solution of Chymotrase is made up weekly. Zonulysin and Chymarzon, being available in small ampoules, are made up by dilution at the operating table.

Surgical Technique

Local anaesthesia was used for nearly all the patients. After premedication with Largactil and Nembutal, anaesthesia and akinesia were obtained with xylocaine and adrenaline. A von Graefe section carried out with a conjunctival frill was

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followed by a single peripheral iridectomy at 12 o'clock. After irrigation of the anterior chamber with Ringer's solution to remove blood clot, A.C.T. (0.25 to 0.5 ml.) was introduced by means of a syringe and lacrimal cannula. In one series (J.E.H.C.), the cannula was passed through the iridectomy, flooding the subiridic space in all directions; in the other (H.M.S.), it was introduced through the pupil under the iris first on one side and then on the other as originally described by Barraquer. In both series great care was taken to ensure the absence of posterior synechiae by moving an iris repositor or the cannula freely under the iris. While the surgeon awaited the action of the enzyme, one, two, or three edge-to-edge corneo-scleral sutures of methylene blue-stained virgin silk were inserted and hooked aside. After 3 minutes the anterior chamber was again irrigated with Ringer's solution to remove any active enzyme. (Barraquer was observed by us to proceed with the extraction after only 2 minutes and to omit the second anterior chamber irrigation.) While the sutures are being placed the cataract is frequently noted to come forward as shown by shallowing of the anterior chamber; less often the pupil becomes smaller as the lens luxates and the anterior chamber becomes deeper.

In one series (J.E.H.C.), the erisophake was used in every case. Controlled vacuometric suction of 250 mm. Hg moulded the capsule and cortex into the dome of the erisophake and achieved a firm grasp of the lens, which could then be removed quite easily because there was no suspensory ligament holding it back. All were round-pupil extractions; no sphincter iridectomies were necessary because the erisophake itself with lens attached successfully enlarged the pupils. Before the use of A.C.T., higher suction pressure up to 550 mm. Hg was often needed to overcome zonular resistance, and tension on the anterior and posterior lens capsules was correspondingly greater. Furthermore, after A.C.T. has dissolved the zonular fibres, no traction on the ciliary body occurs, and no tumbling or external counterpressure is necessary. Provided the section is large enough, the corneal endothelium is not damaged.

In the other series (H.M.S.), Arruga capsule forceps were used and it became necessary to resort to the erisophake only when the cataract was intumescent and the capsule too tight to grasp. The pupil was previously dilated by a mydriatic and further enlarged by an assistant who grasped the iris near the sphincter and retracted it upwards towards the wound. The capsule was then gripped above and the lens slid out without tumbling, encouraged by a little judicious counterpressure from a squint hook placed at the lower limbus.

After the lens had been removed, the iris was replaced, the stitches already in position were tied, and extra ones were inserted as desired. A bubble of air was injected and the conjunctival frill was smoothed over the suture line. Pilocarpine was instilled together with penicillin or chloramphenicol drops. In one series (J.E.H.C.), one eye only was bandaged for 36 hours; in the other series (H.M.S.), both eyes were bandaged for 36 hours after which the second eye was left uncovered.

Presentation of Results

There are many ways of considering a series of cataract operations; in attempting to evaluate a new method of extraction involving an enzyme, it

seems important to try to find whether there has been any unusual trend in the complications at the time of operation or during the period of wound healing which might be attributed to its use. As enzymes of this type are rapidly inactivated in the body, the immediate effects are likely to be the more important. The visual results of the whole series have been carefully analysed, but are not presented in detail as they show no variation from those found in a similar series of round-pupil cataract extractions. Much depends on the condition of the fundus. Almost exactly 75 per cent. of the whole series obtained better than 6/12 visual acuity (usually 6/6–6/9); the remainder obtained less than 6/18 because of the usual defects, including diabetic retinopathy, senile macular degeneration, high myopia, and glaucoma. Two patients died from cardiovascular disturbances during convalescence so that their visual standard was not obtained, and a few of the later cases have not yet been adequately refracted and are not included in this estimate. The great majority of these cataracts were of the senile or pre-senile types: 24 cases were in the 80 to 90 age group, 68 cases in the 70 to 80, 22 in the 60 to 70, five in the 50 to 60, and one in the 40 to 50. One case (J.E.H.C.) was aged 16, and one (H.M.S.) 20 years. The preponderance of older patients is unfortunate, as it is in the younger patients that the strength of the zonule makes intracapsular extraction more difficult and this method could accordingly be of the greatest value.

Summary of Results

Erisophake Series (J.E.H.C.) 72 cases

Complications at Operation:

Broken capsule	5
Failure to grip capsule with erisophake	1
Loss of vitreous fluid	2

Post-operative Complications:

Prolapsed iris	4 (3 with hyphaemata)
Corneal infiltrates	3
Iritis and hypopyon (two diabetics)	3
Severe hyphaemata	1

Forceps Series (H.M.S.) 50 cases

Complications at Operation:

Broken capsule with forceps alone	2
Broken capsule when erisophake was used because of failure to grip capsule with forceps	2
Traumatic cataract in a patient aged 20 years in whom no lysis occurred and an extracapsular operation was performed	1
Vectis removal	1
Vitreous loss	0

Post-operative Complications:

Prolapsed iris	1
Retroversion of iris followed by secondary glaucoma	1

Consideration of Results

(1) *Wound Healing*.—This appeared to be normal in all cases and most of the eyes were soon white. Some showed a transient slight redness round the very fine silk stitches (which are not removed). The suture ends are cut close to the knot at the time of operation, and even those not covered by conjunctiva caused negligible irritation, and that only for a few days. Others showed mild chemosis of the conjunctival frill, which was thought to be due to leakage of aqueous, but this always cleared up spontaneously in a day or so and needed no treatment.

(2) *Intra-ocular Infections*.—There appeared to be no obvious cause for the three cases of hypopyon iritis, but it may be noted that two occurred in diabetics. The two patients who developed corneal infiltrates had their operation on the same day, so that external infection is probable.

(3) *Anterior Vitreous Face*.—This was examined in many cases at the time of refraction for spectacles, and the incidence and degree of hernia through the pupil showed no obvious variation from that found in intracapsular extraction carried out without A.C.T.

(4) *Prolapsed Iris and Hyphaema*.—The four cases of prolapse in the erisophake series were thought to be traumatic. One patient fell out of bed on the 6th night causing a prolapsed iris with a solid hyphaema. The prolapse was excised and her corrected vision 2 months later was 6/24. A second patient pulled up his bedclothes and knocked his eye on the 7th day; a solid hyphaema occurred but within 6 weeks his corrected vision was 6/6. A third patient poked her eye when putting on her tinted glasses on the 7th day; this caused a hyphaema but it had cleared by the 6th week. A fourth patient developed a prolapsed iris at home during the 3rd week; on the 2nd post-operative day there had been a hypopyon iritis which resolved with atropine and hydrocortisone. It may be that wound healing was arrested in this case by the cortisone, but it was not thought that A.C.T. could be held responsible for the prolapse. A fifth patient developed a tiny subconjunctival prolapse which was left alone.

The prolapse in the forceps series was a small one between two sutures and was replaced on the second day.

(5) *Hypermaturation*.—The patient in the forceps series who developed a retroversion of the iris above was aged 46; the cataract was hypermature and could not be grasped with forceps but was removed by the erisophake; the capsule ruptured as the lens came through the incision, but no lens matter remained in the eye. Secondary glaucoma (Schiötz 35 mm. Hg) developed later and was relieved by a cyclodialysis. The eye still remains rather

irritable and the prognosis is uncertain, though at the moment vision is still 6/18.

In the same series a case of bilateral extraction of Morgagnian cataracts (H.M.S.) proved interesting. The right lens began to come forward as the A.C.T. worked and with gentle pressure at the lower limbus slowly delivered itself through the pupil and then through the incision, no attempt being made to grasp the capsule. The other lens did not come forward and the capsule was too tense for the forceps. It was removed by the erisophake (D.C.G.) and the capsule ruptured with escape of milky fluid just as the lens emerged from the wound. Both incisions were sutured without difficulty and with vitreous faces intact. This case introduces the possibility that complete lysis of the zonule may allow the lens to assume an unusually globular shape with tightening of the capsule.

(6) *Unusual Cases.*—The patient in whom the lens was removed by a vectis (H.M.S.) was a woman aged 50 with an old interstitial keratitis and small corneae who had developed bilateral glaucoma at the age of 46. One eye was later enucleated for absolute glaucoma, the other had a trephine in 1950 followed by an optical iridectomy below. A cataract developed and was removed in November, 1958, through a lower incision. Extensive posterior synechiae were broken down mechanically and, although A.C.T. was used and a good grip of the capsule was obtained with forceps, the lens showed no sign of luxation. Fortunately the lower pole was free and could be lifted forwards, so a vectis was slipped in behind it and the lens was successfully removed. The wound was sutured and has healed well.

The capsule broke in another case in which dense fibrous tissue at the back of the lens prevented luxation. A good deal of this was excised with scissors and the remainder contracted leaving a clear pupil.

(7) *Youth.*—A.C.T. produces excellent zonulysis in senile cataracts, but its use for juvenile cataracts appears to be fraught with grave hazards. Our own experience is small, but observation of a series operated upon by Dr. Joaquin Barraquer at his clinic in Barcelona impresses us with the fact that, although an intracapsular cataract extraction can be done, the contents of the eyeball are too traumatized to justify the risk, even using A.C.T. and assuming the very best low tension anaesthesia and the greatest technical skill on the part of the surgeon. The action of the enzyme on the zonular fibres or cement substance is much less effective in young patients, and the attachment of the posterior capsule to the anterior vitreous is very definite. Our own two cases in young people are interesting. One patient aged 16, in the erisophake series, had a successful removal of the lens, but there was alarming herniation of vitreous which settled back after a small fluid loss. This eye has not done well; the media are still not clear and vision is reduced to hand movements. The other patient aged 20, in the forceps series, had an old traumatic cataract. The capsule was easily grasped, but no lysis of

the zonule seemed to have occurred, the lens remaining firmly in its place in spite of the absence of any posterior synechiae. The capsule forceps were therefore removed and an extracapsular operation was carried out.

(8) *Vitreous Loss*.—One case has been described above. The other patient (J.E.H.C.) had a unilateral cataract; and loss of vitreous fluid occurred after completion of the corneal section. The A.C.T. seemed to lack full action on the zonule, as the erisophake at 250 mm. Hg failed twice to extract the lens. Rather than risk suction of solid vitreous, capsule forceps were applied. The lens was lifted forward but found to be adherent to the base of the posterior surface of the iris in one segment. Gentle traction in a horizontal direction gradually peeled it away and the iris was replaced. The patient was 50 years of age and it is believed that he must have had some trauma to his eye to cause this equatorial adhesion. His final visual acuity was 6/6 with glasses. It may be that traumatized eye with vitreous in the anterior chamber is not suitable for the action of A.C.T. if the vitreous acts as a barrier to its effect on the zonule.

(9) *High Myopia*.—It seems to us that it is safe to operate in cases of cataractous high myopia using A.C.T.; two patients had both cataracts removed at the same operation because the first lens in each case came out so easily. We have been fortunate that no lens in our series has fallen back into the vitreous after the use of A.C.T., but this must be accepted as a risk if the vitreous is very degenerate. Fundus changes were severe in these eyes and less than 6/60 visual acuity was achieved by removing the cataracts; but these patients are now more independent and better able to do their house-work. So far we have encountered no complications with high myopes using A.C.T., and we feel that, as there is no drag on the ciliary body, no external pressure, and no tumbling, the risk of subsequent retinal detachment is reduced.

(10) *Acrylic Implants*.—Acrylic anterior chamber lens implants have been successfully inserted in seven cases 6 to 8 weeks after unilateral cataract extraction.

(11) *Comparison of Enzyme Preparations*.—The biochemical analysis of the three varieties of A.C.T. (Chymotrase, Zonulysin, and Chymarzon), was completed by July, 1958, and the assays of their proteolytic action were carried out by September, 1958.

Zonulysin was first used by J.E.H.C. in July, but it failed to act successfully and two capsules broke in successive patients. It was not used again until new material was obtained after further assay and this has proved satisfactory.

Chymarzon has given rise to no difficulty and the fact that it is dispensed in small quantities makes it convenient for small eye centres. It was used in the two diabetic patients who developed iritis, but this was thought to be a diabetic reaction and not due to A.C.T.

Chymotrase has been used in 70 per cent. of one series (J.E.H.C.) and in 100 per cent. of the other (H.M.S.). In the former series it proved entirely successful, except in one case in which the anterior chamber contained vitreous (already described). In the forceps series all the lenses were free, except for the traumatic cataract in the youth of 20 and the two cases which had extensive adhesions (one to fibrous remains in the anterior vitreous and the other as a result of old interstitial keratitis and a trephine for glaucoma). One patient in the erisophake series developed an intra-ocular infection within 24 hours of operation, but as the same *Chymotrase* was used for two other extractions on the same morning without subsequent infection, we feel that it can be exonerated. The patient concerned was a chronic alcoholic aged 80 with poor general resistance; her infection was quickly controlled with antibiotic therapy and hydrocortisone.

Summary and General Impressions

122 cases of round-pupil cataract extraction with alpha-chymo-trypsin are presented. There is no doubt in our minds that the removal of senile and pre-senile cataracts is made much easier by this enzyme, and it is our impression that no damage results to any of the ocular structures from its use. Most surgeons have been successful with the intracapsular method for years past, but in this new way one is relieved of a great deal of tension and anxiety. The battle between the zonule and the capsule is already won by the time one comes to remove the lens, and the vast majority can be virtually lifted out; indeed, now we are accustomed to A.C.T., we would not willingly operate without it.

Our experience in following the Barraquer technique has shown that almost all lenses can be removed by the erisophake in conjunction with the enzyme. Capsule forceps will not remove all lenses and the erisophake must be used when a capsule cannot be grasped. But to those surgeons who are not happy, for one reason or another, to introduce a relatively large suction cup into the anterior chamber and to depend on a mechanically created vacuum, the series of cases in which the well-known Arruga capsule forceps have been used may be of some interest.

The success of the method with cataracts occurring in the lower age groups must await further experience, and this is not likely to stem from Tunbridge Wells.

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