Methylcellulose and lens implantation

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SUMMARY Methylcellulose has been used since 1976 to prevent damage to the corneal endothelium during operations for implantation of intraocular lenses. Originally one drop of a 1% solution was placed on the artificial lens just before its insertion. Later the anterior chamber was completely filled with a 2% solution of methylcellulose before implantation. In this way it is possible to maintain a space between the cornea and iris even if vitreous pressure is present and to operate without risk to the corneal endothelium. This paper demonstrates the safety of the intraocular use of methylcellulose on the basis of over 400 operations. The substance is cheap, universally available, and can be easily prepared for intraocular use.

The past decade has seen the development of the endothelial specular microscope. This instrument led to the realisation that corneal endothelial cells are almost entirely incapable of cell division, and that healing of corneal endothelial wounds can take place only by means of enlargement and sliding of the remaining endothelial cells.

The recognition of this fact fostered a new thinking in ophthalmic microsurgery. Utmost care with respect to the endothelium of the cornea became the law, particularly when a cataract operation was combined with the implantation of an artificial lens. Rules developed to which ophthalmic surgeons should strictly adhere: as little bending of the cornea as possible; as little irritation by an irrigating solution as physiological as possible; absolute avoidance of contact between instruments and the endothelium, and, most important, between the artificial lens and the endothelium.

To lessen the danger of contact between the intraocular lens and the cornea Binkhorst et al. recommended the air cushion technique. Air tends to leave the anterior chamber quickly, however, and to prevent that happening Healon (sodium hyaluronic acid 1%) was recently introduced. The senior author has successfully used methylcellulose since 1976 to prevent the rubbing of the intraocular lens against the endothelium, and because his experience with this substance was extremely favourable he did not change to Healon.

This paper demonstrates the safety of the intraocular use of methylcellulose. In particular, data are presented to show that if there is a methylcellulose-related post-surgical increase in intraocular pressure it is not clinically significant.

Material and methods

Chemistry of Methylcellulose

Methylcellulose used for intraocular surgery is a highly purified brand of hydroxypropyl methylcellulose. The hydroxypropyl and methyl groups replacing hydrogen groups increase the hydrophilicity of the compound. The cellulose polymer is widely found in nature as a structural substance—e.g., in the cells of wood and cotton. The basic molecule is D-glucose. Two monomers of glucose combine to form cellulbiose, which differs from dextrose only in the way the 2 monomers are stereochemically connected: in cellulbiose the bonding is beta-glycosidic, in dextrose alpha-glycosidic. The human enzyme system can hydrolyse alpha-glycosidic bonds but supposedly is incapable of breaking cellulbiose bonding (and therefore methylcellulose), at least in the intestine and in larger quantities. What happens to the minute amount of methylcellulose which may remain in the body after intraocular application is uncertain, but the question seems to be without clinical significance.

Preparation for Intraocular Use

A description is given below of the preparation of a 2% solution of methylcellulose suitable for intraocular use. There are a number of essential points to be considered.

(a) The methylcellulose must be of the highest purity. Methocel E 4 M Premium of Dow

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Chemical Corporation is recommended for use.
(b) A physiological solvent should be used. The
following solvents are suitable: Balanced salt solution
(BSS) (Alcon), Ringer’s solution, Ringer’s lactate
solution, or equivalents.
(c) Antiseptic compounds like benzalkonium,
chlorbutanol, thimerosal, and others are damaging to
the endothelium and must not be used. The solution
therefore has to be sterilised by autoclaving. Since the
internal temperature of a viscous solution rises slowly,
autoclaving should last longer than the usual 20
minutes, i.e., 30–40 minutes.
(d) Some stains which in the past have been used
as ‘vital stains’ were recently shown to be carcino-
genic, e.g., trypan blue. Though this may be of
negligible importance in our context, we now recom-
mand ‘patent blue’ V (sulphan blue), which is known
to be non-carcinogenic.15
(e) A freshly prepared solution of methylcellulose
contains crystalline complexes which form corpuscu-
lar elements. Filtration, therefore, is an essential part
of the preparation of a solution destined for intra-
ocular use.
Preparation of 100 ml of a 2% solution of methyl-
cellulose is as follows: Dissolve 2 g in 30 ml of boiling
solvent (BSS, Ringer’s lactate solution, Ringer’s
solution). Allow to cool. Add 70 ml of cold or icy solvent. The solvent may contain 5 mg of patent blue
V (sulphan blue).15 Store in a refrigerator overnight
at −10 to 0°C.
Next day the solution can be filtered. The pore size
should be between 16 μm and 0.5 μm. One may use
suction by means of a water-stream pump through a
G 3-Fritte, Jenaer Glass (pore size approximately 16
μm) or more conveniently pressure (nitrogen). The
solution is filtered through a Sparkler Submicron
Filter Tube, cartridge CS-0-5 with a pore size of 0.5
μm (Sparkler Inc., Conroe, Texas, USA).
After the filtered solution has been divided into
small bottles, these are sterilised by autoclaving at
120°C for 30–40 minutes.

OPERATIVE TECHNIQUES
All 417 operations on which this paper is based were
performed by the senior author or in his presence by a
junior colleague. The lenses used were mostly
Medallion, but Binkhorst-four-loop, Shearing,
Sinskey, or Sinskey-Kratz lenses were also implanted.
Since the type of lens has no bearing on the post-
operative intraocular pressure, it will not be con-
sidered further in this paper.
The technique of operation was standardised as
follows. All wounds were corneoscleral under a
limbus-based flap reaching from 9.30 to 2.30. All
intracapsular operations were performed with the
help of alpha-chymotrypsine 1:10000 for 2½ minutes.

After implantation of the lens the wound was closed
with approximately 12 8–0 silk interrupted sutures.
During the operation methylcellulose was applied in 2
different ways. From 1976 to 1979 one drop of a 1%
solution was applied to the artificial lens immediately
previous to its insertion. Since January 1980 the
anterior chamber has been filled with a 2% methyl-
cellulose solution prior to implating the lens. After
the lens was in place, sutured to the iris, and some
corneoscleral sutures had been inserted, most of the
methylcellulose was removed from the eye by one of
the following methods: (a) diluting it and rinsing out
with a McIntyre-type coaxial infusion and aspiration
cannula; (b) forcing it out by inflating the anterior
chamber with air; (c) a combination of these 2
methods, either simultaneously or consecutively.
For the past few months a methylcellulose solution
has been used which is stained slightly blue to help
observe its disappearance. No attempt was made to
remove all the methylcellulose, since the blue specks
which remained at the end of the procedure had
disappeared on the first postoperative day.

POSTOPERATIVE MEASURES
All patients received topical applications of dexam-
ethasone 0.1% q. i. d. from the last preoperative
day for several weeks. This might have contributed to
the fact that there was a slight rise of pressure during
the early postoperative period. Therefore all patients
received acetazolamide in sustained release form
(Diamox Sequels) 500 mg daily, from the day of the
operation to the third postoperative day. Diamox
Sequels was given irrespective of whether the
operation was an intracapsular (with alpha-
chymotrypsin) or extracapsular (without alpha-
chymotrypsin) procedure. The postoperative intra-
ocular pressures of days 1 to 3 were under the
influence of acetazolamide; at day 4 there may have
been a residual effect.
Appplanation tonometry was performed at the first,
third, and fifth postoperative days. A pressure-
lowering treatment was reinstituted in about 5% of
the cases on the fifth postoperative day. This did not
influence the results presented below.

Results

OPERATION
The use of methylcellulose greatly facilitated the
operation. If despite ocular massage the anterior
chamber remained shallow, the methylcellulose
always increased the depth of the chamber to allow
for an easy and safe implantation (even of 3-plane
lenses with the ‘open-sky’ route) without a Sheets
glide or posterior vitrectomy. The implantation never
had to be abandoned, in contrast to its abandonment
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in about 10% of cases prior to the use of methylcellulose.

All the types of intraocular lens used by us could be implanted without touching the cornea and could, as was generally done, be sutured to the iris without harming the endothelium. Moreover, it was easier to observe the tying of the iris suture knot through the cornea if the anterior chamber was filled with methylcellulose rather than with air.

POSTOPERATIVE INTRAOCULAR PRESSURE

When the pressures after use of 1% and 2% methylcellulose were compared it was evident that they were no higher after 2% methylcellulose. (The pressures were slightly lower in fact after both intracapsular and extracapsular procedures.) Therefore the groups of patients receiving 1% and 2% methylcellulose were combined in the figures presented below.

Fig. 1 shows the postoperative intraocular pressure after planned intracapsular operations (i.e., with application of alpha-chymotrypsin 1/10000 for 2½ minutes). It should be remembered that the intraocular pressures from day 1 through day 3 were influenced by the application of acetazolamide.

Fig. 2 shows the intraocular pressure after planned extracapsular operations (alpha-chymotrypsin was not used in these eyes, but the eyes did receive acetazolamide).

Fig. 3 shows the intraocular pressure in a small group of secondary implantations of medallion lenses. These operations differ from those shown in Figs. 1 and 2 in that they were less traumatic. Acetazolamide was given in these cases also.

The 3 figures demonstrate clearly that the increases in intraocular pressure after a cataract operation with lens implantation (or after a secondary lens implantation), during which methylcellulose has been applied, are not a complication of clinical significance.

POSTOPERATIVE INFLAMMATION

No postoperative infections occurred. Possibly because of steroid treatment postoperative intraocular inflammation was minimal. Only slight flare
and a few cells were observed for a few days. No hypopyon occurred. (All lenses had been wet-
sterilised by Medical Workshop.) Only a few eyes with a more pronounced exudation were observed. 
This could not have been the result of the methyl-
cellulose, because the methylcellulose was always 
withdrawn from one bottle for several implantations, 
while the postoperative cases of iritis occurred only 
sporadically, never epidemiically.

**POSTOPERATIVE STATE OF THE CORNEA**

Each operation was graded according to a subjective 
impression of quality, and later compared with the 
postoperative appearance of the cornea. In the cases 
with the highest grade (most eyes), the corneae were 
nearly clear at the first postoperative day, and 
completely clear by the third day.

The endothelium was observed postoperatively in 
about 100 cases by noncontact specular microscopy 
and with the help of a McIntyre grid and compared 
with the nonoperated eye. In most of the operated 
eyes there were about 2000 endothelial cells per 
mm2 in both eyes. To us this indicated a lack of 
any toxic effect of methylcellulose on the endo-
thelium.

Therefore as a clinical impression on the basis of 
approximately 2000 postoperative slit-lamp 
examinations on 417 eyes it can be stated that 
methylcellulose did not harm the endothelium. Since 
the mechanical advantage of this adjunct to the 
operation is so evident, the overall effect on the 
cornea must obviously be beneficial.

**Discussion**

Healon was recently considered ‘the most important 
substance to come along in cataract surgery since 
alpha-chymotrypsin’. This statement, however, 
must be qualified. What matters is not Healon but 
appropriate viscous material in the eye. Healon, 
despite its value, has its disadvantages: it is very 
expensive, not universally available, and it is difficult 
to dilute. For the last reason a relatively large amount 
of the material may remain in the eye and cause a 
dangerous rise of pressure postoperatively.

We prefer methylcellulose 2% dissolved in BSS. 
Fleming et al. have shown that methylcellulose 
inside the eye is harmless. Methylcellulose has many 
advantages. As an adjunct to lens implantation it is 
perfect. It coats the lens and deepens a shallow 
anterior chamber. It is universally available and 
expensive. The solution is comparatively easy to 
preserve—at least for a moderately equipped 
pharmacy. This is advantageous in underdeveloped 
and developing countries. The solution can be 
resterilised, thereby further decreasing the cost 
factor. It can be stained blue for easy recognition 
inside the anterior chamber. It is—and this is a very 
important point—easily diluted and can be largely 
removed from the anterior chamber without diffi-
culty. If postoperative rises of intraocular pressure 
occur owing to its use, they are easily manageable and 
not clinically significant.

Because methylcellulose is a nonphysiological and 
possibly nonmetabolic substance consisting of large 
polymers, it could be argued that the residue which 
remains in the eye at the end of the operation might 
clog the trabecular meshwork and cause dangerous 
bouts of glaucoma, as has been reported after the use 
of Healon. Our results show that this is definitely 
not so. As can be seen from Figs. 1 and 2, the intra-
ocular pressure at the first postoperative day was 33-1 
mmHg after intracapsular operation, and 30-2 mmHg 
after extracapsular operation (with acetazolamide).

Obviously the difference between the pressures must 
be due to the increased tension following the 
enzymatic zonulysis. But even after extracapsular 
operation pressure rises occur which seem in the 
first place to be due to the trauma of the operation 
and lens material remaining in the anterior chamber.

It is unclear whether remnants of methylcellulose in 
the anterior chamber in addition increase the post-
operative intraocular pressure. Whether this is so— 
and if so, to what extent—could not be clarified.

What was shown, however, was the unequivocally 
benign behaviour of the methylcellulose inside the 
eye with respect to the postoperative pressure.

As regards the argument that methylcellulose 
cannot be metabolised, one must consider the 
quantity under discussion. If 20% of what was 
inhaled into the eye—say 0.5 ml—stays in the 
anterior chamber, this amounts to only 2 mg of the 
dry substance of methylcellulose, a substance 
considered to be inert and confirmed by our 
experience to be so. None of the patients showed any 
ill effect either systemically or locally which could 
be related to methylcellulose.

With respect to the cornea we did not prove that 
methylcellulose was more beneficial than Healon or 
air or no cushioning substance at all. But since most 
eyes which where examined by noncontact specular 
microscopy did show a very high endothelial cell 
count (practically equal to that of the nonoperated 
eyes) we feel justified in the assumption that methyl-

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*[Note: The text continues with further discussion and observations.]*
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anterior chamber. Admittedly this statement is based on clinical experience. We hope that this paper may stimulate further investigations to obtain confirmation.

We obtained the solution of methylcellulose from Raths-Apotheke, Oster-St 51, 3250 Hameln, West Germany.

References