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EVALUATION OF BALANCED SALT SOLUTION IN KERATOMILEUSIS

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In this study the aim was to evaluate Belanced Salt Solution* in keratomileusis[1] as a substitute for a solution of normal saline for the washing and thawing of corneal lens tissue. This solution contains the required basic salts for cultivating living tissues in vitro. It is isotonic, possesses the necessary ions for cellular metabolism and is weakly buffered to the pH of the ocular fluids.

Studies by Pomerat and Overman[2] and Merrill, Fleming and Girard[3] demonstrated that Balanced Salt Solution did not damage the corneal or intraocular tissues, whereas the 0.9 percent sodium chloride solution showed damage in vivo and in vitro. These studies, together with other related published results [4, 5, 6], encouraged the author to evaluate Balanced Salt Solution as an irrigating solution in keratomileusis.

Keratomileusis is an intervention carried out on a healthy cornea in order to modify its refractive power and thus correct severe defects of refraction of the eye. The operation consists of the following steps:

1. Resection of the anterior layers of the cornea. (Obtaining a disc of corneal tissue).
2. Freezing of the disc.
3. Optitcal cutting of the disc in the frozen state. (Corneal tissue lens).
4. Thawing.
5. Repositioning of the corneal tissue lens.
6. Suturing corneal tissue lens into place.

* Supplied by Alcon Laboratories, Inc., Fort Worth, Texas.

In performing a keratomileusis cells of the corneal parenchyma are traumatized by the section and by the solution employed for lavage and thawing of the tissue. In order to minimize the damaging effect produced by irrigating solutions, Balanced Salt Solution was evaluated as a possible replacement for normal saline in this procedure.

On the other hand, the characteristics of this procedure allow surfaces of the irrigated section to be in mutual contact (interface) in the center of a transparent medium (the cornea) which permits its observation under the microscope and the slit lamp from the first postoperative day.

This operative procedure resembles an anterior lamellar keratoplasty with the advantage from a biological point of view of being an autoplasty but with the disadvantage of the tissue having to be frozen to make it firm enough to be ground to the desired optical refraction which imposes an additional trauma to the corneal cells.

One of the problems arising from this intervention is the presence in the interface of opaque objects which diminish transparency of the cornea. These opacities may come from:

a) the air
b) the operative field including gauze and cotton sponges
c) the sutures
d) the medicinal and cleansing solutions
e) remains of necrotic cells from the surgical sectioning procedures and medicinal solutions.
f) interlamellar areas of infection of a mycotic or bacterial origin.

Foreign bodies are visible from the first postoperative day and produce opacities similar to those found in lamellar keratoplasty. The opacities become accentuated during the course of the second week due to tissue reactions which are caused by their presence. Upon resorption of the irritating substances or when they become englobed, the opacities diminish and disappear.

Opacities due to cellular necrosis are diffuse and appear during the second week; they are almost completely reabsorbed in the following weeks. Those resulting from infection are dense, localized and have a characteristic appearance.

To avoid the above problems we have for several years eliminated the use of talcum powder in the operating room, substituted plastic surgical drapes for those made of cloth, used polyvinyl sponges, and brushes made of pine martin hair in place of gauze and cotton tampons. We have covered denuded surfaces with special protectors and have used antibiotics systemically. These measures have reduced

the number of foreign bodies and areas of infection considerably that we had previously experienced.

There remain three main sources of opacities in the interface, namely.

a) cellular remains
b) foreign bodies brought in by washing solutions, air and instruments.
c) fibers carried by suture threads.

We reasoned that Balanced Salt Solution with its isohydric and cytophilic properties would reduce the opacities due to cellular necrosis. In addition, the fact that it could be used directly from the original container, a pliable plastic bottle, should reduce the introduction of foreign bodies in the interface. To this end we proceeded to employ this solution in ten consecutive cases of keratomileusis and compared the results obtained with ten cases, also consecutive, in which normal saline was used.

The Balanced Salt Solution was used directly from the sterile plastic bottle in which it was supplied by means of a silver, gold or stainless steel canula. It was used in irrigating the corneal disc after removal, the corneal tissue lens and the corneal section surface. At the end of surgery it was used for final cleansing irrigation of the interface after the corneal lens had been sutured in place. The solution was warmed to 37º C for use in thawing out the frozen corneal lens after optical cutting. The normal saline solution was placed in a Petri dish and then aspirated into a syringe to irrigate the tissues during the various operative phases.

The patients were examined by slit lamp during the postoperative and recovery periods as indicated below, using the following criteria for evaluating the new drug:

a) presence of foreign bodies in the interface
b) presence of cellular detritus.

PRESENCE OF FOREIGN BODIES IN THE INTERFACE

In the cases in which Balanced Salt Solution was used as per the surgical procedures previously indicated, we were able to verify the following:

Case Nº 1 — Very scarce foreign bodies (powder)
Case Nº 2 — Absence of foreign bodies
Case Nº 3 — Two small foreign bodies of metallic luster (probably from some instrument).
Case Nº 4 — Absence of foreign bodies
Case Nº 5 — Scarce grains of powder

Case Nº 6 — Absence of foreign bodies
Case Nº 7 — Absence of foreign bodies
Case Nº 8 — Absence of foreign bodies
Case Nº 9 — A fiber 1 mm in length (possibly from the sutures)
Case Nº 10 — Absence of foreign bodies.

PRESENCE OF CELLULAR DETRITUS OBSERVED DURING THE SECOND POSTOPERATIVE WEEK BY EXAMINATION WITH THE MICROSCOPE AND SLIT LAMP.

Case Nº 1 — Clear interface
Case Nº 2 — Interface with some cellular detritus
Case Nº 3 — Clear interface except a small inferior external zone of approximately 1 mm with cellular debris.
Case Nº 4 — Clear interface
Case Nº 5 — Clear interface
Case Nº 6 — Clear interface
Case Nº 7 — Clear interface
Case Nº 8 — Clear interface
Case Nº 9 — Clear interface
Case Nº 10 — Clear interface.

CONTROL CASES

Ten consecutive cases of keratomileusis were used as control cases. In these patients normal saline solution was used in the various operative procedures.

Case Nº 1 — H-31.706
a) Absence of foreign bodies.
b) Some detritus in the interface.

Case Nº 2 — H-50.952
a) Many foreign bodies in the interface.
b) Cellular detritus in the interface. Irrigation was necessary on the 11th day to eliminate it.

Case Nº 3 — H-50.908
a) Interlamellar foreign bodies.
b) Cellular detritus in the interface. Irrigation on the 20th day to eliminate the detritus.

Case Nº 4 — H-51.012
a) Abundant foreign bodies.
b) Much cellular remains. Interface was washed on the 30th day.

Case Nº 5 — H-24.370
a) Interlamellar foreign bodies.
b) Cellular remains. Required irrigation on the 12th day.

Case Nº 6 — H-50.869
a) Absence of foreign bodies.
b) Absence of cellular remains.

Case Nº 7 — H-51.252
a) Absence of foreign bodies.
b) Very scarce cellular necrosis.

Case Nº 8 — H-17.365
a) Absence of foreign bodies.
b) Slight interlamellar necrosis.

Case Nº 9 — H-24.311
a) Absence of foreign bodies.
b) Absence of cellular necrosis.

Case Nº 10 — H-51.146
a) Two interlamellar filaments.
b) Absence of cellular necrosis.

TABLE I

	NORMAL SALINE SOLUTION		BALANCED SALT SOLUTION	
Case	*Foreign Bodies*	*Cellular Remains*	*Foreign Bodies*	*Cellular Remains*
Nº 1	— — — —	+ + — —	+ — — —	— — — —
Nº 2	+ + + —	+ + + —	— — — —	+ + — —
Nº 3	+ + — —	+ + + —	+ — — —	+ + — —
Nº 4	+ + + —	+ + + —	— — — —	— — — —
Nº 5	+ + — —	+ + — —	— — — —	+ — — —
Nº 6	+ — — —	+ + — —	— — — —	+ — — —
Nº 7	— — — —	+ + — —	— — — —	— — — —
Nº 8	— — — —	+ + — —	— — — —	— — — —
Nº 9	— — — —	+ — — —	+ — — —	+ — — —
Nº 10	+ — — —	— — — —	— — — —	— — — —

RESULTS OF COMPARATIVE STUDY

In Table I we have schematically compiled the results for the study which may be summarized as follows:

With the use of the normal saline solution both the number of interlamellar foreign bodies and the quantities of opacities due to cellular necrosis were so plentiful that in cases 2, 3, 4 and 5 it was necessary to carry out irrigation of the interface in the postoperative course. This was probably due to the fact that the normal saline solution was exposed to the air when transferred from its original flask to the Petri dish and from it to the syringe.

In cases in which Balanced Salt Solution was used there was a minimum number of foreign bodies which were apparently from other origin. The opacities due to cellular necrosis were so few that it was not necessary in any of the cases to postoperatively irrigate the interface.

CONCLUSION

From this study it is concluded that Balanced Salt Solution is chemically less traumatic to the cells than normal saline solution. Its manner of preparation and packaging permits direct application of the solution without contamination by the atmosphere, reducing considerably the introduction of foreign bodies into the surgical wound. In no case in which Balanced Salt Solution was used were processes of septic origin observed.

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