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VITRECTOMY:
Instrumentation

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Vitreous is a three-dimensional meshwork of protein fibrils with hyaluronic acid and water lying between it. Vitreous has tissue-like properties. Therefore removing is only possible by cutting in into pieces.

The first who suggested vitrectomy as a routine procedure was KASNER. He sucked the vitreous at a sponge, drew it in front of the iris diaphragma and cut it with a scissor. This rather traumatic and time consuming procedure requires a large corneal incision and the removal of the lens. Because of its approach it is called open-sky-vitrectomy (fig. 1).

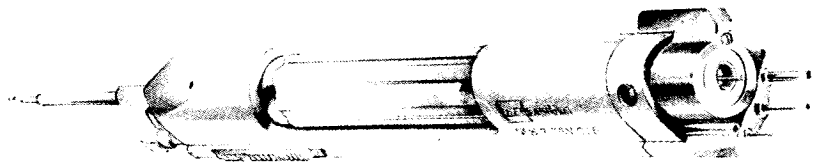

FIGURE 1

Further improvement took place, when special instruments were developed. The common principle of these devices is to suck vitreous in a hole at the tip of a cannula and cut it into pieces mechanically at the edges of this hole. The cut-off little portions of vitreous then can be sucked

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through this cannula and thus removed. If the removed vitreous simultaneously is replaced by a suitable saline solution, vitrectomy is possible by the pars-plana-approach. The anterior segment of the eye now remains untouched.

Despite the fact, that now vitrectomy-instruments are mainly used in pars-plana-vitrectomy they are also of great advantage in open-sky-technique. It is evident that a smooth cannula is far less traumatic to the endothelium and iris than sponge and scissor.

To control the manipulations in the posterior parts of the eye special illumination problems arise. They can be compared with the slitlamp and contact-glass examination of the fundus. Coaxial illumination of a microscope and special devices are used. Although reflexes at the optical surfaces and a "light-haze" due to dispersion of light cannot be avoided. An intraocular illumination does not have these disadvantages. Together with the vitrectomy-canula a fiber-optic light-pipe is inserted into the eye. Thus a high-contrast and reflex-free image of the operation area deep in the eye can be obtained for the pathways of observation and illumination now are different.

Sometimes a successful vitrectomy means also removing vitreous structures which are very close to the retina. The danger of cutting the retina then has to be considered. Preparations with the tip of the vitrectomy-instrument or —better— with a second instrument inserted into the eye, can be an advantage. Now these structures can be removed from the retina and can be sucked off and cut in a safe distance of it. This bimanual technique seems to be one of the latest improvements in the field of vitrectomy.

From what has been said till now follows that a vitrectomy instrument must be able to cut, to suck, to infuse, to illuminate and to be suitable for preparations.

All these funtions become effective in the eye via one or two cannulas which should have a diameter as small as possible. They are naturally not generated in this cannula. In the till now published vitrectomy instruments, the cutting mechanism is driven by a motor or a solenoid which is built in the handpiece of the instrument. Suction, infusion, illumination and power-supply for the motor is generated in some distance to the operating area and gets to the cannula via pipes and the handpiece. The control and adjustment of the single functions is done by the surgeon himself or by assistants at command of the surgeon.

Inspite of the fact that the cannula with all its properties is the integrating part of a vitrectomy instrument, many other auxilliary devices are necessary to make a vitrectomy possible. Consequently vitrectomy requires not only a vitrectomy instrument but an instrumentation-system.

To characterise some of the more well known vitrectomy instruments we shall now look at the differences concerning the single functions.

The most important detail of a vitrectomy instrument is the cutting mechanism and here we also find the major differences. There are two principles, in which cutting edges can be moved in a cannula. Movement in axial direction or turning a cutting blade in the tip of the cannula.

PEYMAN for instance has published a vitrectomy instrument which uses the end at an inner cannula and the edge at the hole in the side of the outer cannula as cutting branches. Vitreous sucked into the hole is cut when the inner cannula is pushed down.

The cutting device of the "vitreous stripper" described by KLOTI is built somewhat inverse to that of PEYMAN. Here the outer cannula is open and has a sharp edge. The inner stands out and has a hole in the side. Sucked in vitreous is cut when the inner cannula is drawn in.

As examples for the turned mechanism we shall look at the devices of MACHEMER, DOUVAS and HENNIG.

In the VISC of MACHEMER the conical tip of a cannula rotates in a conical bearing at the outer cannula. Therefore the cutting edge of the inner part moves past the hole and cuts the sucked in vitreous.

DOUVAS has designed a vitrectomy instrument with an alternatingly rotating system. One half of the inner cannula is ground away thus forming the cutting edge which moves past the hole in the outer cannula (fig. 2).

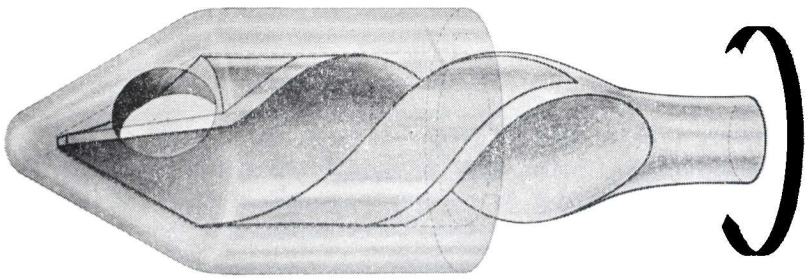

FIGURE 2

The "vitreophage" of HENNIG again has a conical bearing but the inner part is a drill-shaped tool with two cutting edges. Here the suction hole is never closed completely, so the suction is nearly continuous. The motor of the "vitreophage" can be controlled by a switch which is built in the handpiece. The rate of rotation is adjusted at the power-supply-unit (fig. 3).

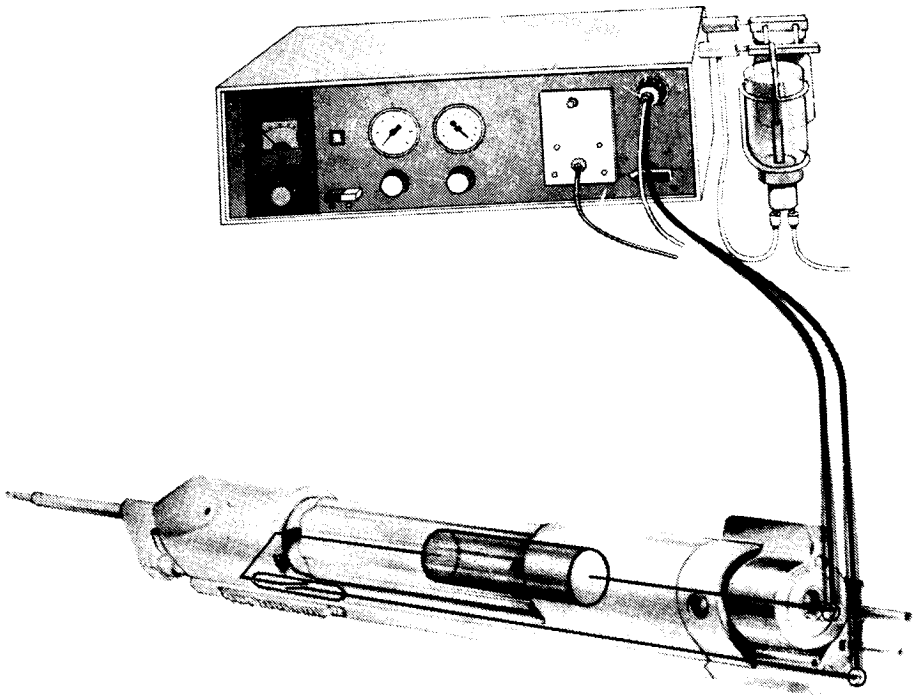

FIGURE 3

Concerning the suction there are minor differences between the till now published instruments. To generate the suction MACHEMER and some others use a syringe, which is operated by an assistant. DOUVAS has an electronic control system and KREIGER has published a foot-switch. (Fig. 4). In the "vitreophage" a continuous suction is applied to a suction

chamber with a bypass-hole. Only when this hole is closed by a fingertip the suction reaches the suction hole in the tip of the cannula. Therefore the surgeon himself has an immediate on-off control.

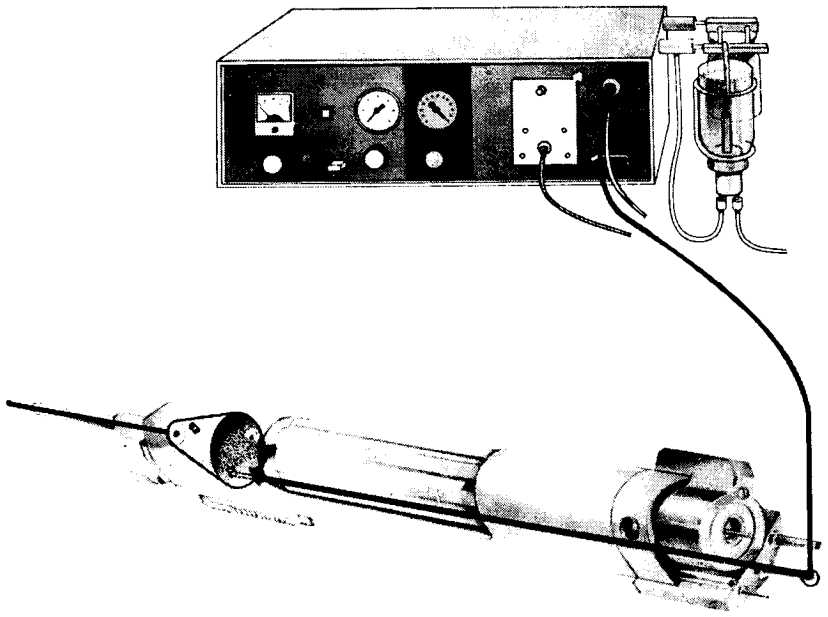

FIGURE 4

Most vitrectomy instruments get the infusion from a normal infusion bottle. The pressure is regulated by the altitude of the bottle. (Fig. 5). Another possibility is to apply air pressure at an infusion bottle. Thus the adjustment of the infusion-pressure can be more precise and comfortable. To get both —suction and infusion— to the tip of the cannula, the pathways must be separated. This is obtained by a double-walled cannula or by using the gap between the inner and outer cannula of the cutting system. When using the bimanual technique suction and cutting is at one

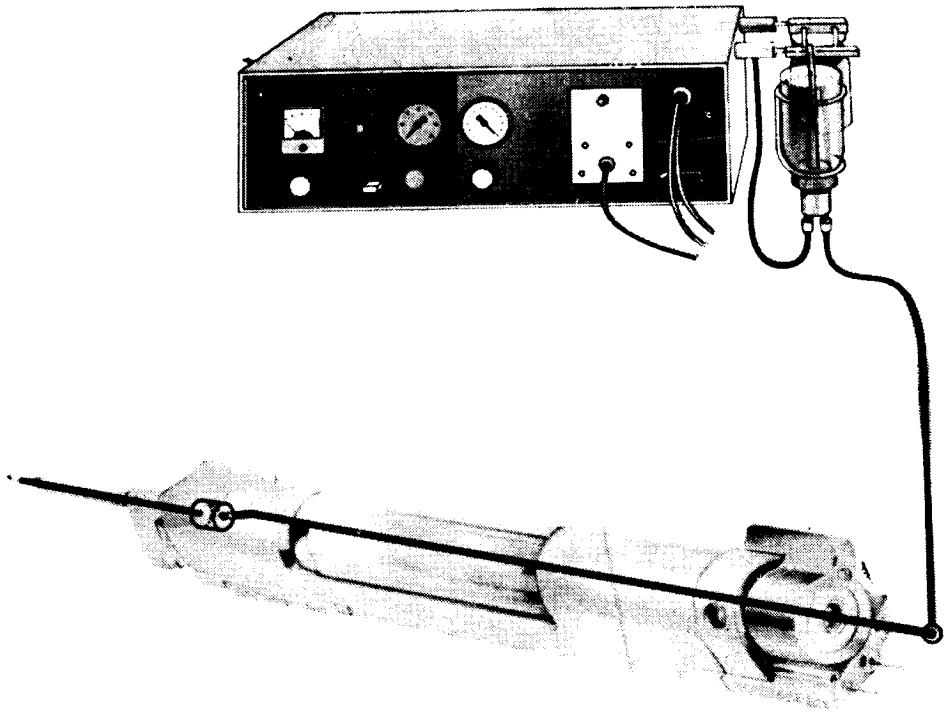

FIGURE 5

hand and the infusion at the other, thus an interference between suction and infusion at the tip can be avoided (fig. 6).

Intraocular illumination is only possible with an extraocular light-source and a fiber-optic lightpipe which surrounds the cannula of the vitrectomy instrument. It is also reasonable to put the illumination at the left hand in case of bimanual procedure. For now the illumination can be moved independently to the suction hole and different light effects e.g. dark field, —retrograde— and wide angle illumination can be obtained.

MACHEMER has suggested to use the infusion cannula in bimanual technique for preparations near the retina. The tip of the cannula should be bent in an angle of 80º for this purpose. If there are tough strands or membranes in the vitreous it can be of advantage to cut them with a

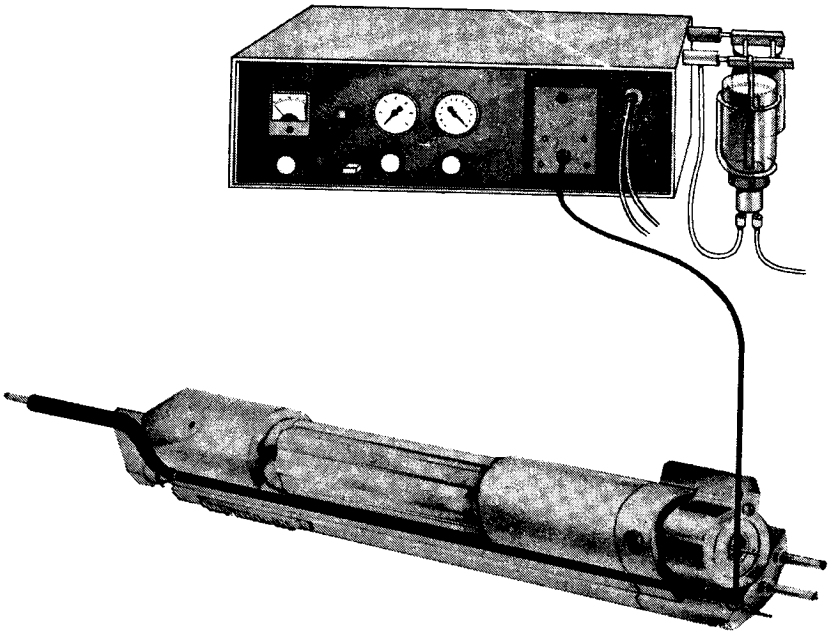

FIGURE 6

micro-scissor before removing them with the "vitreophage". A micro-scissor with built in infusion-channel therefore has been developed for the vitrectomy system MS 7. It can be used instead of the plain infusion cannula at the left hand.

With regard to the technical effort the pars-plana-vitrectomy requires a rather delicate and sophisticated instrumentation. Suction and cutting the vitreous as well as infusion and illumination has to be managed reliably. Unexpected events make the direct control of the main functions by the surgeon himself desirable.

As an example for a complete system I will show you now the vitrectomy-instrumentation-system MS 7, designed by me (fig. 7).

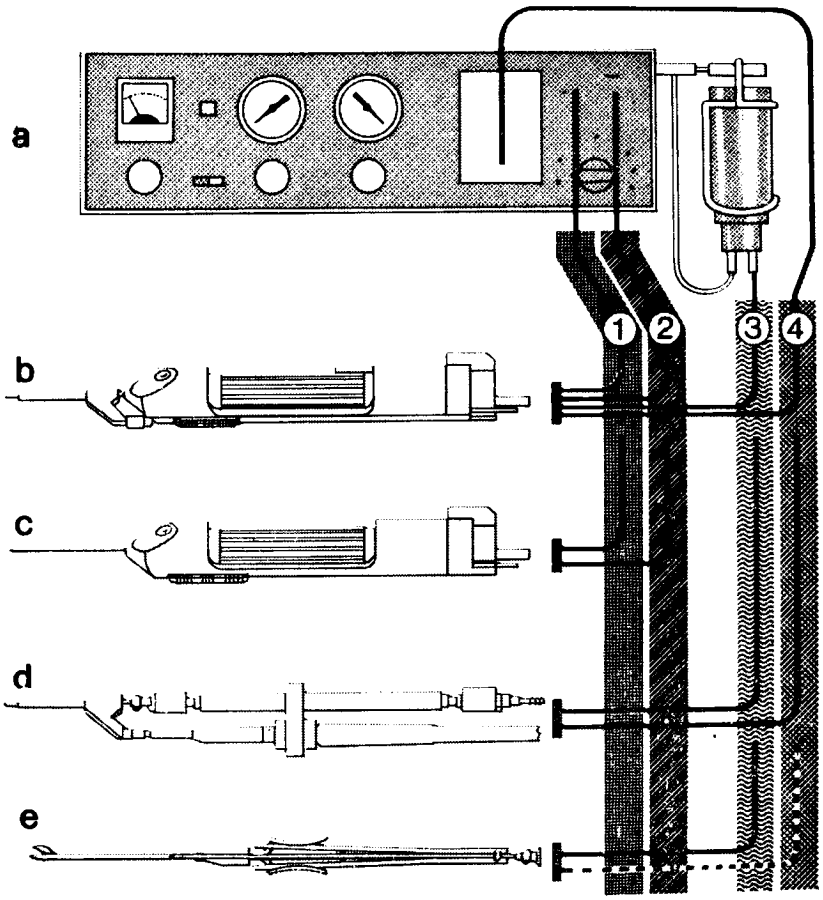

FIGURE 7

In the power-supply-unit (a) where the suction, infusion-pressure, current for the motor and illumination is generated these functions also can be adjusted. Over a flexible cable the handpiece is connected with the unit. At the handpiece the three main functions: cutting, suction and infusion can be started or stopped. For the "one-hand"-vitrectomy this handpiece (b) contains all necessary functions. Next you see the "vitreophage" designed for open-sky-technique and bimanual technique (c) without infusion and illumination. The device for the second hand (d) then contains these two functions. Below of it is the micro-scissor with built in fusion (e) which can replace the infusion cannula in the device above if it is desirable.

SUMMARY

The vitreous is a tridimensional mass of protein fibrils with hyaluronic acid between them. It may only be cut in pieces. Kasner used to fix the vitreous with a sponge in front of the iris, cutting it with a scissors. In this procedure, called open sky vitrectomy, a large corneal or corneo-scleral incision and removal of the lens is required.

At present, with the development of new instruments, the vitreous is suctiond through a hole located at the end of a cannula, and it is cut into pieces mechanically at the edges of this hole, being removed by suction. Simultaneously, the removed vitreous is replaced by a convenient saline solution. The vitrectomy is possible through the pars plana without touching the anterior segment.

An instrument which may suction, cut, infuse, and illuminate the inner part of the eye is presented. The surgeon may use one or two cannulas of a very small diameter. The motor of the instrument is located at some distance from the operated area, and its control and adjustment is made by the surgeon or his assistant.

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