Prototype for Eye Surgery.

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Abstract

The Prototype for Eye Surgery has four systems: the cut system, aspiration system, infusion system and illumination system.

To make the design of this prototype it is necessary to involve in vitrectomy surgery and investigation. Additionally, it is important to attend surgeries to know the work of the surgeon with the vitrectomy equipment so that understand the needs of the surgeon in a vitrectomy surgery.

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1. Introduction

The purpose of the project is design, program a prototype for ocular surgery, that accomplishes the requirements of a vitrectomy surgery with materials of easy acquisition in the local market, standard accessories that can reduce the cost of vitrectomy surgeries and so that more people can access to surgeries especially poor people.

In Ecuador many people with vitreous problems do not have money to pay for a vitrectomy surgery.

Vitrectomy is a vitreous surgery performed to safely remove vitreous gel from the middle of the eye without damage to other intraocular structures. Vitreous is a jelly structure that fills the ocular cavity and can not be regenerated.

The design of this vitrectomy prototype starts with the investigation about vitrectomy surgeries. Once there is the knowledge about vitrectomy the next step is attend to vitrectomy surgeries in the operating room with the approval of an Ophthalmologist. Vitrectomies in Ecuador are performed few times per month.

2. Problem statement

The presence of diseases related to the vitreous of the eye lead to the need of making a surgery using the Vitrectomy equipment to improve the sight of the patient and avoid early blindness.

The vitrectomy equipments that are sold in Ecuador are of exclusive brands, replacement and technical staff. A vitrectomy surgery is more expensive when the equipment and accessories for surgery are more expensive.

As the surgeries are expensive in our country many people with vitreous problem from Ecuador do not have money to pay the cost of a vitrectomy surgery.

3. Purpose of the project

Making a vitrectomy prototype, that accomplishes the requirements of a vitrectomy surgery with materials of easy acquisition in the local market, standard accessories that can reduce the cost of vitrectomy surgeries and so that more people can access to surgeries especially poor people.

As vitrectomy surgery is a complex procedure it is required the experience and skill of the surgeon. This prototype can be useful for the learning of Ophthalmologists because the cost will be less than using imported equipment.

The veterinarian ophthalmology has taking importance the last years. For this reason this vitrectomy prototype is an alternative to give solutions to diseases

related with vitreous in animals to give them comfort and health. By this way the surgery in animals will be cheaper.

Moreover, this vitrectomy prototype can give the possibility to use standard vitrectomy probes and infusion cannulas.

4. Objective

- Design and build a prototype for intraocular surgery.
- Design a cut system to cut the vitreous in tiny pieces making easier the suction of them.
- Design an aspiration system that allows removing the vitreous pieces from the eye.
- Design an infusion system to keep the moisturizing in the eye.
- Design an operator panel to visualize and modify process variables.
- Test the equipment with similar substances to the vitreous.
- Test the prototype in the surgery room with a surgeon ophthalmologist using postmortem pig eyes.

5. Vitrectomy

5.1. Definition

Vitrectomy is a vitreous surgery performed to safely remove vitreous gel from the middle of the eye without damage to other intraocular structures.

Vitreous is a jelly structure that fills the ocular cavity and can not be regenerated.

Vitrectomy is used to clear vitreous opacity, remove blood and scar tissues in the vitreous, treat infections and repair retina and other parts.
Blood, scar tissues and opacities cause blurred vision or blindness.

5.2. Instruments for vitrectomy

The main instruments used in a vitrectomy surgery are: vitrector, infusion cannula and endoilluminator probe.

Vitrector is the tool to cut and aspirate the pieces of vitreous. It has two lines one for cutting and the other for aspirating.

The cut line allows controlling the opening and closing of the cutter blade and the aspiration line controls the suction of vitreous.

Infusion cannula keeps intraocular pressure and replaces the vitreous by a Balance Salt Solution. It is connected through a bottle that is gravity dependent and has inside a balance Salt Solution.

Endoilluminator probe illuminates the eye´s cavity. It has optic fibers to make easier the vision of ophthalmologist during the surgery.

5.3. Vitrectomy procedure

Vitrectomy is always done by an Ophthalmologist who has special training in treating problems of the eyes.

The surgeon will make three scleral incisions in each of them he inserts the infusion cannula, vitrector and the endoilluminator probe into the eye.

The vitrector cuts the tissues in small pieces in the opening of the tip and the pieces are aspirated by the aspiration line.

The vitreous is replaced by a balanced salt solution throw the infusion cannula.

The light source is directed onto the area where surgeon is working with the vitrector.

During the vitrectomy doctor set the values according to each patient, but the common number of cuts per minute is around 1000 and aspiration from 100 mmHg to 200 mmHg.

5.4. Ocular conditions that require Vitrectomy

A vitrectomy surgery is used with Diabetic retinopathy and other problems related to the vitreous cavity. A Diabetic retinopathy is a disease that suffers most of the people who has diabetes.
It is useful with bleeding inside the eye, damage to surrounding tissue, injuries, diseases or infections.
A vitrectomy is done in people with problems related to previous eye surgery.

6. Systems of the Vitectomy Prototype.

The vitrectomy prototype has 4 systems: cut system, aspiration system, infusion system and illumination system. The vitrector used is a 23 gauge that can allow 1000 cuts per minute.

6.1. Cut system

The cut system is compound by vitrector that can reach 1000 cuts per minute.

A program was made for this system using a microcontroller. The control of the cut line allows controlling the opening and closing of the cutter blade of the vitrector.

This system is pneumatic and the control of the cutter blade of the vitrector is made using air through an electric valve. The valve is activated by the orders of microcontroller.

6.2. Aspiration system

The aspiration system has an air pump to provide a vacuum to aspirate vitreous. There is a container that keeps the pieces of vitreous that are aspirated.

A pressure sensor measures the vacuum pressure. The vacuum got is near 300 mmHg and the vitrector can work with vacuum pressures nearly to 300 mmHg as it is a 23 gauge probe.

The aspiration line controls the suction of vitreous using an electric valve that keep vacuum in an established value. The valve is activated by commands of the program of the microcontroller which activate the driver to move an engine. This engine moves the position of the valve.

6.3. Infusion system

The infusion system has a bottle of balanced salt solution which is gravity dependent, an infusion cannula is connected to the bottle and a valve to open and close the irrigation inside the eye.

The infusion system is compound by a clutching electric valve, this valve is operated by the orders of a microcontroller which activate the valve. This valve clutches the pipe to stop the infusion pass through the infusion cannula.

6.4. Illumination system

The illumination system has an endoilluminator probe. This endoilumminator is compound of optic fiber that has a tip on it that lets pass the light to the eye cavity. There is a led and a configuration that allow the light pass from the led to the optic fiber.

7. Design of the Prototype

This prototype was designed with: materials of easy acquisition in our country, reusable and recycle parts.

The design of this vitrectomy prototype starts with the investigation about vitrectomy surgeries. Once there is the knowledge about vitrectomy the next step is attend to vitrectomy surgeries in the operating room with the approval of an Ophthalmologist. Vitrectomies in Ecuador are performed few times per month.

Attending to surgeries is important to understand the needs of the surgeon with the vitrectomy equipment during a surgery.

The analysis and investigation of accurate and accessible options let develop the control of the prototype systems.

The inventiveness and knowledge let make the design and build sources, electronic cards, aspiration valves, keyboards, control panels and the case of the equipment.

The programming of microcontrollers to control the different systems, activating or deactivating valves allow to reach the desire goals.

Once the hardware and software is joined it is available to control the whole system.

The tests of the vitrectomy prototype were done in substances similar to vitreous and using postmortem pig eyes in the theatre with the help of ophthalmologists.

8. Conclusions

The number of cuts per minute and vacuum are established by the type of vitrector.

The vitrector that is used is the 23 gauge which allows 1000 cuts per minute and around 300 mmHg.

The vitrectomy prototype is made with materials of easy acquisition in the local market, standard accessories that can reduce the cost of vitrectomy surgeries and so that more people can access to surgeries especially poor people.

The prototype was used to perform the surgeries of vitrectomy using pig eyes so that the surgeon could see the power of the cuts and aspiration. In these tests we got good results because during the surgery the eyes kept their shape and didn't collapse. Additionally the number of cuts and aspiration were adequate during the process and the cuts of vitreous were developed efficiently.

9. Reference list

Ashok Garg, Jorge L. Surgical Techniques in Ophthalmology Retina and Vitreous Surgery. Jaypee Brothers Medical Publishers ltd. 2010.