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Eye Drug Dispensing Glasses

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Abstract: ***This project focuses on old age people or people who suffer from serious eye problems who are not able to deliver the drug into eye by themselves (in cases of muscle dystrophy), and is case of blepharospasm. The dispensing of drugs into eye are less efficient and lead to loss of drug and also may lead to unwanted infections, and in cases of glaucoma where the patient has to put drug of specific amount daily in the eye. The main idea is to make a system which is simple and deliver the drug easily with maximum accuracy. The project focuses on making a glass and band system. The glasses are designed in such a way that it perform two main functions one is to retract open the eye, and second create vacuum to prevent infection when drug is delivered in the eye. Once the eye is retracted the bottle is fixed on the top most part of the glass for dispensing drug. Upon pressing the bottle drops enters the eye through the hole done on the equidistance from the eye so that the drop enters the eye only. This project is designed for independently delivering the drug into the eye.***

Keywords: Eye glasses, blepharospasm, drug delivery, eye retraction, eye drop dispensing

1. Introduction

Human eye is the most important and sensitive part of human body. A seat of vision and sensation, a way to perceive things, analyze and then take decisions. Any disorder in human eye can lead a lot of problems. People from all age groups face a lot of problems in eye. Some people have disorders of eye which are due to muscle, some have vision problems, some have due to glucose- blood levels and many are suffering from eyesight problems. One such case is blepharospasm (blepharon, eyelid, and spasm, an uncontrolled muscle contraction), is any abnormal contraction or twitch of the eyelid. It is of two types: essential and reflex blepharospasm. The benign essential blepharospasm is a focal dystonia a neurological movement disorder involving involuntary and sustained contractions of the muscles around the eyes. The term essential indicates that the cause is unknown, but fatigue, stress, or an irritant are possible contributing factors. In most cases, symptoms last for a few days then disappear without treatment, but sometimes the twitching is chronic and persistent, causing lifelong challenges. In those rare cases, the symptoms are often severe enough to result in functional blindness. The person's eyelids feel like they are clamping shut and will not open without great effort. Patients have normal eyes, but for periods of time are effectively blind due to their inability to open their eyelids. In contrast, the reflex blepharospasm is due to any pain in and around the eye. Although there is no simple cure botulinum toxin injections may help temporarily. A surgical procedure known as myectomy may also be useful. It is a fairly rare disease, affecting only one in every 20,000 people in the United States.

There are cases of glaucoma which also require continues care of eyes. Glaucoma is the term applied to a group of eye diseases that gradually result in loss of vision by permanently damaging the optic nerve, the nerve that transmits visual images to the brain. The leading cause of irreversible blindness, glaucoma often produces no symptoms until it is too late and vision loss has begun. The two main types of glaucoma are open-angle glaucoma, which has several variants and is a long duration (chronic) condition, and angle-closure glaucoma, which may be a sudden (acute) condition or a chronic disease. Damage to the optic nerve and impairment of vision from glaucoma is irreversible. Several painless tests that determine the intraocular pressure, the status of the optic nerve and drainage angle, and visual fields are used to diagnose glaucoma. Glaucoma is usually treated with eye drops, although lasers and surgery can also be used. Most cases can be controlled well with these treatments, thereby preventing further loss of vision.

Many other cases like conjunctivitis, corneal abrasion, redness of eyes due to foreign object in the eye they all need the use of eye drops to be administered in the eye regularly in many cases the human is not able to do flexion motion and the hand is shaking as in Parkinson’s disease and could not deliver drug by him/herself. The system designed is very simple and allow such patients to deliver drug daily in the eye without any problem and efficiency of the system is 100% as tested on a sample of 50 people.

2. Research Objective

Problem statement: Easy delivery of drug in the eye with least efforts done by the user.

The following are the specific research objectives:

1. To find out people who are real need of the equipment to be made a rough survey of the need of a device to help such patients.
2. Designing a simple device can be easily worn and used to deliver the drug.
3. Designing a glass which can be worn on the eye.
4. Designing the system to retract open the eyes.
5. Designing the system to hold the bottle and easy squeeze and deliver effect.

3. Literature Review

3.1 An improved technique of eye drop self-administration for patients with limited vision

In this paper it mainly focuses on improvised tactile technique for eye drop self-administration for patients. The method was found to be highly accurate and reliable method for administering eye drops to patient’s eye. In the above technique ten patients were taken for the purpose of experimentationthat had fixation problems(≤20/400) in one of their eyes and ten adult patients were taken with a loss of fixation in both the eyes. The eye drops were then introducedinto one eye which in turn producesartificial tears in each eye using thesame normal technique. The time required to instill each drop were been noted, the number of drops squeezed from the bottle, and location of the drops landing points on the face or eye were also then recorded and also the time were noted down. Those patients with loss of fixation in one eye took extra time to administer a drop using the new technique. The accuracy of drop placement had been increased from 80.0% to 82.5%.

3.2 Accuracy and performance of a commercially available Travatan Dosing Aid

In this paper a device was made to administer eye drops and the product was commercially available in the market and hence to evaluate the recently introduced Travatan Dosing Aid (TDA) for its accuracy in recording and dispensing eye drops. Here the number of eye drops was dispensed with each lever depression and the total numbers of drops dispensed were recorded by the device which was evaluated in a controlled setting. Eye drops were reliably recorded by the TDA after each full lever depression.

3.3 Evaluation of the Xal-Easeiatanoprost delivery system

In this paper we came across a delivery system which was named as Xal-Ease manufactured by Pfizer Ophthalmic. The purpose of this system was to compare drops of iatanoprost dispensed using the Xal-Ease delivery system with drops dispensed manually. About Twenty-four 2.5-mL bottles of Xalatanwere evaluated and tested with or without the delivery system. Individually dispensed drops were then counted. The total volume dispensed was measured to be around 10 μL and the statistical analysis compared group means by analysis of variance. The P values were found to be less than 0.05 were considered significant.

3.4 Study of eye drops dispensing and dose variability by using plastic dropper tips

In this article we studied about the eye drop dispensing and dose variability by using plastic dropper tips.The eye drops from flexible dropper bottles were fitted with different types of dropper tips whichwere associated with the high variability of eye drop weights. The aim of this report was to investigate or to identify the simultaneous effect of three factors influencing the mean weight of drops dispensing from two plastic dropper tips. There was a significant effect of the increase in concentration, which resulted in a lineardecrease in drop weights for both of the dropper tips. The significant effect and the dispensing angle was influenced by the dropper tip design and it was been noted. For the dropper tip A, the effect of the dropper tip tilt was been described by using quadratic equation with a minimum angle equal to that of 48° from the horizontal. Below this angle, there was an increase in drop weights occurred due to the drop formation from the wetted external surface of the tip orifice. There was a linear decrease in drop weights in response to the decrease in dispensing angle was been finally detected for the dropper tip B.

Numerical investigation of topical drug transport in the anterior human eye In this article we first discuss about the topical drug transport and briefly describe about the eyes and diseases related to it. Anterior eye diseases are been commonly treated by topically applied drugs in the form of eye drops or ointment. In order to understand the effectiveness of topical drug administration, it is very important to understand temporal evolution and spatial distribution of the drug in the anterior eye. In this article we saw a lot of model of topical drug transport in the anterior human eye being developed.

The Spatio-temporal evolution of drug concentration was then investigated numerically, with a clear focus on the drug concentration at three different targets which include the trabecular meshwork (TM), iris and lens. The results clearly showed that after the drug diffusion across the cornea, a process called convection took place in the aqueous humor (AH). The flow was a dominant mechanism of transport for all topically applied drugs in the anterior human eye. In this article we also saw the effects of eye orientation and the effects of ambient temperature. Ambient temperature was found to play an important or major role in the transport of topically applied drugs. With the increase in the ambient temperature, the peak concentration of the target at first decreased, and then increased. Eye orientation was then found to influence the maximum drug concentration at different targets.

The results obtained helped us to understand the drug transport process in the anterior human eye, and provide a clear cut idea of topical drug administration in order to improve the delivery efficacy.

3.5 The effect of needle gauge, needle type, and needle orientation on the volume of a drop

Here we studied about the effect of needle gauge and needle orientation mainly. The purpose of thisstudy was to determine impact of needle gauge, type, and orientation on average volume of drop dispensed. The methods include using five needle gauges (22G, 23G, 25G, 27G, and 30G) were examined. For each gauge the volume of drop delivered was determined for standard sharp beveled tip, blunt tip, and after breaking off of the sharp needle from the hub. In the results the mean drop volume was affected by needle gauge, needle orientation, and whether the needle had been broken off from its hub. Blunt needles tend to produce larger drop volumes compared to sharp beveled needles, but these differences did not reach statistical significance. Breaking off the needle from the hub producing substantially larger drop volumes with little difference being found between needle gauges. In the end these findings have helped us for controlled delivery of topical ophthalmic medications to patients

4. Methodology/Approach

The approach of the system to be designed was done by considering three main parameters. The parameters were making a secure system to take full care of the eye, a very simple and easy acquisition of the system, a mechanically strong system which can retract open the eye by itself without any human hands interference. Hence while designing the same system all the above parameters were satisfied. The concept was to make such a glass which while wearing on the eye retracts open the eyes by the pull of the band and create the suction between the eyes. The retraction of the eyes will include opening the upper and lower lids of the eyes simultaneously hence making maximum probability of delivery of the drug in the case of people with excess blinking problems and people who can't open the eye lid by themselves. The suction produces an atmosphere of vacuum between the eyes and the vacuum thus formed will actually keep eyes away from any other dust particle or any infection source at the time of delivery of the drug into the eye. Hence making the system infection-proof and making it more susceptible to be used by the people. The main idea was to make a system to put drug in both the eyes either simultaneously of one by one without any further adjustment of the system by the user. Upon literature review and a lot of survey from the local people around we found out that making a simple glass is a good idea. Then a small trial on the people in our university was done. Total of 50 people were tested and maximum people gave positive results upon the working of the system.

The system is divided in two main parts:
1. The design of eye glass.
2. The system to hold the bottle and dispense drug.

Design of Eye Glass

The main part of making the drug delivery glass is the design of the eye glass, making a very simple yet effective glasses, easy to use and administer the drug. The research included strenuous efforts to make the glasses and many trials were done to come to a conclusive design of the glasses. The final prototype design will be shown in figure 1 and figure 2 show below respectively.

The eye glass designed is based on the concept of retraction of eye automatically when the glasses are worn by the patient and also the system to hold the bottle. A mechanical model was made in which the inner flaps of eye glass were designed in the concave shape which when worn will open the eyes. The retraction of eye is done by using a polymeric rubber which is biocompatible and also does not cause any itching and does not puncture the eye, because the design is set at the parameters which will take care of such odds. The band is made from the edges round the head and tightened at the back. The tightening of the band will produce suction and create vacuum in the eye, this vacuum created will take care that no foreign particle enters the eye while administration of the drug. The concavity made on the inner portion of the eye can lead to a little of discomfort upon first time use by the user but upon continuous use the rubber will help settle the system on the eye and make is more smoother and easy to handle.The glasses are made up of polyacrylic material. The upper part of the glass is designed to hold the bottle and the rings are made to fix the bottle in the socket created in the glass. The specifications of the size of the glass used and the design is such that the glass made is round in shape, glasses installed in the system will be in the centre of the whole round block. With depth from the glass to the eye being 2cm, and the height on the upper edge will be 2-3cms. The inner side of the system will have a glass and a small hole about the size of the orifice of the bottle. Such that bottle will be fixed at the hole created at an equidistance from the centre, to allow delivery of the drug directly into the eye without any wastage of the drug. The round part of the system will be made with the dimensions as follows: The volume of the orbital margin is $30cm^3$. Hence the glass size is made with the volume more than the inter orbital volume. To help the system to fix exactly on the orifice of the eye, whole inner part of the round system is coated with rubber to help provide cushion and comfort to the user using it.

Design of the upper part of the glass

Now the basic design of delivery of the drug is made with keeping the round glass as the basic considerable model. The round glass is centered and a diameter equal to the diameter of the bottle was made with threads made on the inner surface of the glass. The threadsare made to tighten the bottle in the glasses. The bottle tightens in the glass orbit made; the bottle penetrates to the centre of the glass. The centre of the glass has a small orifice almost of equal diameter to that of the drug delivery bottle. The system allows the bottle to get fixed exactly to the centre of the glass. The user after fixation press the bottle gently the drug from the system moves through the bottle to the orifice and then through the hole enters the centre of the eye. The eye drop drops exactly inside the eye with the positioning of the eye done at particular angles. The normal phase of the human body is assumed to be at 0 degree phase with head and the equidistant plane which include head, neck and whole body in one straight line. First condition is when the head moves back to the phase change of say 30 degrees going posterior to the original position, Second condition when the head is tilted more at an angle 40 degrees to the origin. In such cases the delivery of the drug into the eye will have maximum efficiency. The other case is when the person is laying down on floor, with ventral side of the body facing upwards. The whole body system is at 0 degree with complete body laying on ground and the system worn on the eye. The drug delivery bottle is at an angle 90 degree to the glass. The possibility of the drop going into the eye is maximum with very less chances of errors. The system is not susceptible to the shakes and ill movements done by the user because it will produce error to the dropping drop. Hence the system made should be used in equilibrium state without much movement.

5. Figures and Tables

Figure 1: Designed system of the internal structure of the glass.

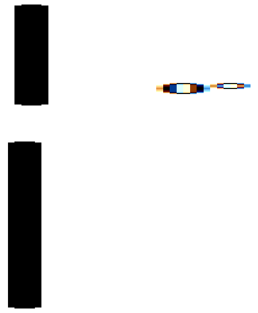

Figure 2: The Top portion denotes head and the bottom portion denotes body standing in vertical position in zero degree.

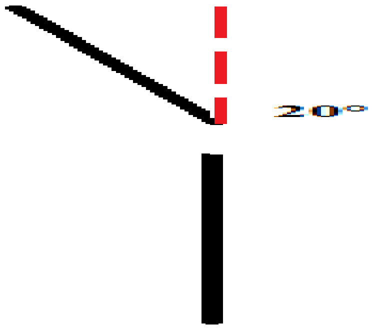

Figure 3: The head is inclined at an angle of 20 degrees

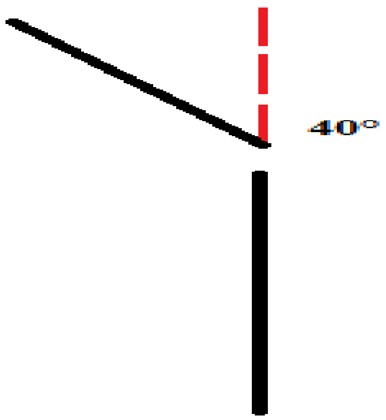

Figure 4: The head is inclined at an angle of 40 degrees

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Tarundeep Singh Kalsi is a student of Vellore Institute of technology, Doing engineering in biomedical, I am an innovator, aim to become a successful business man. Had won awards in competitions for innovating new equipments in healthcare i am a quick learner, hard worker and like to think. Aim and vision of life is to make products, become a successful businessman and work to enhance healthcare and make mankind healthier.

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