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Is There a Need for New Surgical Procedures for Glaucoma? Yes!

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Abstract: The only method to slow or stop progressive damage caused by glaucoma, the leading cause of irreversible blindness, definitively shown to be effective, is lowering intraocular pressure, though there is also evidence that stabilizing the pressure may be beneficial. Performing surgery on the eye has proven effective in some cases, using various techniques, though with variable frequencies of success (stabilization of the disease) and various frequencies and severities of complications. Surgery offers the great advantage of longer duration of action than medicinal treatments presently available, and, also, of lessening the need of the patient to be faithful using suggested medications. There is a need to develop surgical procedures which will be effective in 1) lowering or stabilizing intraocular pressure in a way most likely to prevent glaucomatous deterioration, 2) causing the fewest and least severe problems, and 3) being the most economical. Recent efforts in this regard are promising, but not yet proven superior to well-performed trabeculectomy, itself an evolving procedure.

Keywords: Complications, Cost/benefit ratio, cost effectiveness, effectiveness, glaucoma, guarded filtration procedure, minimally invasive glaucoma surgery, surgery, trabeculectomy.

INTRODUCTION

If there were a very safe, very effective surgery for glaucoma, glaucoma would no longer be the leading cause of irreversible blindness. To consider the future, it is often helpful to examine the present. There are three different ways to consider the fact that surgical treatment for glaucoma is in many ways quite similar to the surgery that was performed 50 or even 100 years ago. It could be a sign of lack of innovation or creativity, or, on the other hand, it could be an indication of the brilliance of the individuals who first developed surgery at the close of the 19th Century. A third interpretation would be that advancing the art and science of glaucoma surgery is so extraordinarily difficult that there really have been almost no viable options other than those methodologies developed many years ago [1-6].

Because current glaucoma surgeries are difficult and often associated with complications, there is great interest in developing new surgical procedures. The impetus for this is driven by two different considerations: in the first place, the current standard, trabeculectomy, is a difficult operation, labor intensive, and, as often performed, accompanied by complications, both short term and long term. Some surgeons do not feel an urgency about developing new surgery because they are quite comfortable with the performance of trabeculectomy and, in their hands, the complication rate is remarkably low. The senior author of this paper, for example, is still enthusiastic about trabeculectomy as a fine operation. His papers appear to indicate that flat anterior chambers, excessively soft eyes, leaking filtration blebs, and ophthalmitis are uncommon [7-13]. Furthermore, reviews by Watson, Ridgway, and others suggest a long term success rate in the 80 percent range, the procedure lasting for the duration of the patient's life [14-17]. These results, however, are in contrast to many other studies from centers where surgeons are clearly highly competent and a great deal of surgery is performed [18-23]. A general consensus has developed that trabeculectomy tends to fail after about five years in around 50 percent of the cases [18-20, 22-25].

The second driving force fueling the interest in newer types of glaucoma surgery relates to a complication rate which accompanies the "usual" way in which trabeculectomy is performed, and which is disturbingly high. Underlying this difference in rate of complications of "trabeculectomy" is a remarkable lack of agreement as to how to perform the operation [26]. Indeed the very name, trabeculectomy, itself is confusing, because as currently performed, very few surgeons actually excise trabecular meshwork. The operation should more accurately be called a guarded keratosclerectomy, or, more simply, a guarded filtration procedure.

The search for an optimal way to lower intraocular pressure in patients with glaucoma is not new. Trabeculectomy itself was developed as a way to decrease the rate of complication from full thickness filtration procedures [14, 17, 27-31]. The concept of a "guarded filtration procedure" was advanced by Shaffer and others [31, 32].

An additional reason why there is an interest in developing filtering glaucoma surgery relates to the obvious problems that many patients do not take medications as suggested, many patients do not have access to medications and cannot keep the frequent office appointments that are required in order to be sure that the medications are working,

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and many patients cannot afford the costs of years of treatment with the medications. Were a very effective, very safe glaucoma procedure available, the likelihood is that it would be widely utilized and would result in a gratifying and substantial decrease in the now disturbingly large number of individuals who lose vision from glaucoma, which is the leading cause of irreversible blindness in every country in the world [33-35]. Furthermore, it is likely that this disturbing statistic will become even more disturbing because glaucoma is more frequent in the elderly and the world's population is aging markedly [36-38].

This brief review of the history of glaucoma surgery up to the present is necessary before speculating about what will happen in the future. Also necessary is an understanding of when surgery is necessary and what it aims to accomplish. In the simplest terms, were it possible to perform a surgical procedure that would be 100 percent successful in preventing the development of progressive optic nerve damage and do it without causing complications, it would be possible to eliminate many of the tests that are presently required to determine if a person really does have glaucoma and if he or she is getting worse, and at what rate. At the present, the only justification for any treatment of any kind, including surgery, is a relative certainty that without treatment the person will develop a decrease in quality of life and a disability. Every treatment that we have at present itself causes some type of decrease in quality of life, and that includes both medical and surgical treatments. From a theoretical point of view, then, a totally effective, totally safe treatment would be a complete game changer, because then it would be possible to operate on people in whom the future was uncertain, but in whom there was a reasonable likelihood that they might develop a decreased quality of life or disability related to glaucoma. Is such a goal possible to achieve? The answer is, "no," when one considers the current approaches to glaucoma surgery.

Glaucoma is a process in which tissues become damaged, most particularly the optic nerve. If vision is lost because the optic nerve becomes damaged, it is conceivable that it would be possible to strengthen the lamina cribrosa. This could be done by a nanotechnological method that might impregnate the lamina with cellular material and endogenous connective tissue, or even an exogenous plastic. Patients with ocular hypertension have an abnormally thick lamina cribrosa. While it is possible that the elevation of intraocular pressure stimulates the development of such a protective barrier, the more probable theory is that patients who (for whatever reason) have thicker lamina cribrosas are less likely to develop glaucomatous optic nerve damage because the thicker lamina protects the nerve fibers more carefully than the lamina that is thinner. What is conceivable is that providing support to the connective tissue surrounding the optic nerve would prevent the nerve from enlarging, and could perhaps prevent the enlarging nerve from damaging the neurons as they pass through the lamina.

Another approach would be to develop a micro tubular network that would lie on the surface of the globe, and would be connected to a stent in Schlemm's canal (an extension of the current stent technology). It might be possible to develop an artificial bleb connected to a sclerectomy opening from the anterior chamber, similar to the sclerectomies presently made during full thickness or guarded filtration procedures. This artificial bleb would have a programmable surface allowing more or less aqueous to filter through it underneath the conjunctiva.

Nano technology could possibly create a pressure sensitive trabecular meshwork. A different approach would be infiltrating the ciliary body secretory cells with tiny, programmable chemical structures that would suppress aqueous production.

Having proposed some truly novel approaches to the surgical treatment of glaucoma, we wish to return to what is more realistic, more immediate, and more likely to occur, specifically, continuing revision and modification of guarded filtration procedure. It is likely that continued experimentation will result in improvement, due to new agents that will modulate wound healing, continuing development of the use of releasable or modifiable sutures, ways to measure aqueous production inexpensively and reliably, and, importantly, better understanding of the genetic characteristics which predispose to certain types of outcomes.

While the existence of a filtering bleb is frequently looked on as a negative, the bleb may constitute a type of decompression chamber, which may explain the remarkable stability of intraocular pressure throughout the day and over the years that is associated with successful guarded filtration procedures. It is unlikely that surgeons will abandon a procedure which continues to be improved and continues to be effective in preventing visual loss in those with the single largest cause of irreversible blindness. Better ways of regulating intraocular pressure around the time of surgery will also be found with regards to tube shunt procedures, increasing their already great value.

In summary, it is likely that filtration procedures in various forms will continue to be the work horses of glaucoma surgery, with increasing ability to personalize the technique of surgery depending upon the particular needs of the individual patient, related to genotype, inflow, amount of optic disc damage, rapidity of deterioration, styles characteristics, and many other considerations.

CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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