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The critical role of the conjunctiva in glaucoma filtration surgery

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A B S T R A C T

This review considers the critical role of the conjunctiva in determining the success or failure of glaucoma filtration surgery. Glaucoma filtration surgery can be defined as an attempt to lower intraocular pressure (IOP) by the surgical formation of an artificial drainage pathway from the anterior chamber to the subconjunctival space. Many types of glaucoma filtration surgery have been developed since the first attempts almost 180 years ago. The wide range of new techniques and devices currently under investigation is testament to the limitations of current techniques and the need for improved therapeutic outcomes. Whilst great attention has been paid to surgical techniques and devices to create the drainage pathway, relatively little attention has been given to address the question of why drainage from such artificial pathways is often problematic. This is in contrast to normal drainage pathways which last a lifetime. Furthermore, the consequences of potential changes in aqueous humour properties induced by glaucoma filtration surgery have not been sufficiently addressed. The mechanisms by which aqueous fluid is drained from the subconjunctival space after filtration surgery have also received relatively little attention. We propose that factors such as the degree of tissue damage during surgery, the surrounding tissue reaction to any surgical implant, and the degree of disruption of normal aqueous properties, are all factors which influence the successful formation of long term drainage channels from the conjunctiva, and that these channels are the key to successful filtration surgery. In recent years it has been suggested that the rate of fluid drainage from the subconjunctival space is actually the determining factor in the resultant IOP reduction. Improved knowledge of aqueous humour induced changes in such drainage pathways has the potential to significantly improve the surgical management of glaucoma.

We describe for the first time a novel type of drainage surgery which attempts to minimise surgical trauma to the overlying conjunctiva. The rationale is that a healthy conjunctiva allows drainage channels to form and less opportunity for inflammation and scar tissue formation which are a frequent cause of failure in glaucoma filtration surgery. Successful drainage over extended periods of time has been demonstrated in monkey and rabbit eyes. Long lasting drainage pathways were clearly associated with the presence of lymphatic drainage pathways. A new philosophy in glaucoma drainage surgery is proposed in which minimisation of surgical trauma to the conjunctiva and the encouragement of the development of conjunctival drainage pathways, particularly lymphatic pathways, are central pillars to a successful outcome in glaucoma filtration surgery.

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1. Introduction

Glaucoma affects around 70 million people worldwide. It is the second most common cause of blindness and the leading cause of irreversible blindness (Husain et al., 2005; Quigley, 1996). The importance of lowering intraocular pressure (IOP) in delaying glaucomatous progression has been well documented (Heijl et al., 2002). When drug therapy fails, or is not tolerated, surgical intervention may be warranted. One avenue for surgery is a filtering procedure, such as trabeculectomy or drainage implant surgery, which creates an artificial outflow channel between the anterior chamber and the subconjunctival tissue. This pathway thus circumvents any pathological obstruction to outflow. Over almost two centuries many different approaches to this fundamental principle have been developed. Even today there are numerous new techniques and devices being developed. The reasons for continued development relate to the limitations inherent in all procedures developed to date. Surgical complications can include hypotony, scar tissue formation and subsequent bleb failure. The bleb, formed by the pooling of aqueous humour beneath the conjunctiva and/or Tenon's capsule, is considered to be the cornerstone of IOP control in glaucoma filtration surgery, but it is also an unstable and pathological tissue (Classen et al., 1996). Bleb-related complications can be serious and the surgeon has little control over the final appearance of the filtering bleb after surgery (Azuara-Blanco and Katz, 1998). Such complications require very careful management to avoid loss of vision.

We will briefly review the history of glaucoma drainage surgery and the possible changes in the aqueous humour itself and its interaction with conjunctival cells and tissue after glaucoma filtration surgery. We will also show our findings of aqueous humour drainage pathways from the conjunctiva demonstrating the critical roles of conjunctival lymphatics in aqueous flow pathways after glaucoma filtration surgery.

2. Glaucoma filtration surgery

Glaucoma filtration surgery is a fistulising procedure that provides an alternative drainage route allowing aqueous to escape from the anterior chamber to the subconjunctiva in order to lower IOP.

2.1. History of filtration surgery

The association between glaucoma and elevated IOP was first suggested by Bannister in 1622 (Duke-Elder, 1969). More than 200 years later, the first fistulising procedure was reported by MacKenzie (Azuara-Blanco and Katz, 1998). Subsequently, filtration surgery has been refined and success rates have increased (Ritch et al., 1989). There have been significant contributions made by numerous surgeons in this field.

Beginning early in the 20th century, various materials, including horsehair, silk thread, metals, plastics, and iris tissue were incorporated in limbal wounds to maintain fistula patency (Antoszyk et al., 1986; Lehman and McCaslin, 1959; Minckler et al., 1987; Molteno, 1981; Peiffer et al., 1990; Stefansson, 1925; Troncoso, 1940, 1949; Wolfe and Blaess, 1936; Zorab, 1912). Various substances were also placed in the suprachoroidal space through cyclodialysis clefts to maintain filtration (Troncoso, 1940).

Trabeculectomy, developed 40 years ago {Koryllos, 1967 19136/id; Cairns, 1968 15378/id; Sugar, 1961 19135/id}, was a remarkable