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The Filtering Puncture - A New Surgical Procedure in Postoperative Serous Choroidal Detachment

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Abstract

Purpose: To suggest a new manner of performing the scleral puncture (the filtering puncture) in serous choroidal detachment (SCD) after glaucoma (G) surgery. This procedure is based on a pathogenic mechanism denied by modern literature: the aqueous humor (AH) migration through cyclodialysis slit or pores.

Method: After conjunctiva incision and anterior chamber (AC) filling with saline, a 3 mm long sclera incision is practiced at 4 mm from the limbus by a knife in pars planum above both SCD lobes, at 5 and 7 o'clock. If the AC flattens in parallel with fluid egress through the scleral puncture, when opened, a second, perpendicular, 3 mm long incision is practiced at one end of the puncture and the scleral corner thus delineated is excised. The AC is reformed with air until the iris/lens diaphragm is slightly concave. Conjunctiva suture.

Material: 12 consecutive cases between 1984-1987 with postoperative SCD resisting to the conservative attitude underwent the new procedure 7 days after external drainage G surgery (Vancea trabeculectomy-7 cases, Cairns trabeculectomy-3 cases, trabeculokeratencleizis-2 cases). For each case, two filtering punctures were practiced (infero-internal and infero-external), because the simple puncture produced fluid egress in both sectors.

Results: The AC was normal from the first postoperative day, with the air bubble freely floating in AH in all cases. The bed rest and binocular patch ceased immediately and the patient left the hospital the following day. No case relapsed. The inferior conjunctiva remained raised by a flat filtering bleb for the next 3-7 days. For comparison, from the previous 25 cases when I practiced the nonfiltering punctures (by blade or diathermy), 7 cases (28%) needed a second puncture, and from these, 2 cases needed a third puncture (28.57%). With one exception, each puncture was practiced after 7 days of failed medical treatment. No external sign of filtration was observed in the conjunctiva covering the nonfiltering punctures.

Keywords: *Filtering Puncture; SCD; Trabeculectomy; SEDPea; Athalamia*

Abbreviation

AC: Anterior Chamber; AH: Aqueous Humor; CT: Cairns Trabeculectomy; EDPea: External Drainage Procedure with External Approach; G: Glaucoma; HRUBM: High Resolution Ultrabiomicroscopy; IOP: Intraocular Pressure; OVD: Ophthalmic Viscoelastic Device; SCD: Serous Choroidal Detachment; SEDPea: Small fistula, External Drainage Procedure with External Approach; T: Trabeculectomy; T-K: Trabeculokeratencleizis; VT: Vancea Trabeculectomy; WEDPea: Wide fistula, External Drainage Procedure with External Approach

Introduction

In spite of all the progress so far, the trabeculectomy (T) remains the golden standard in glaucoma (G) surgery, or at least, "the standard against which to measure other technologies" [1], especially when low teens in intraocular pressure (IOP) are aimed for in the postoperative interval to stabilize progression [2]. It is true that the recent years have brought novelties: [3-5] ab interno implanted transscleral shunt for external drainage surgery (XEN gel stent); and various procedures for ab interno internal drainage G surgery: trabectomy and excimer laser trabeculotomy; implants for by-passing the trabecular resistance (I-stent), or for enhancing the uveo-scleral pathway (Cypass); procedures or implants for stretching the trabecular membrane in order to enlarge its pores (viscodilation; canaloplasty; hydrus scaffold; Stegman Canal expander, etc.). Quite unfortunately: the price is prohibitive for most patients; some procedures produce endothelial complications; and the long-term pressure results are not superior to the ones after T. That is why I am certain that the classic wide external drainage procedures under scleral flap with external approach (WEDPea) have a future: some of these T-like procedures will be complicated by serous choroidal detachment (SCD), so that the interest of this paper will be maintained for a certain period.

In modern literature, the risk of developing postoperative SCD after G surgery does not show much difference after T-like procedures (1.4 - 34%) and after glaucoma implant procedures (2.7 - 35%) [1-21]. The accepted mechanism of postoperative SCD is transudation/exudation [6-13], to which my previous studies have added the aqueous humor (AH) migration through cyclodialysis slit or pores [20,21].

The recommended attitude in postoperative SCD continues to consist of bed rest and binocular bandage + antibiotic, anti-inflammatory and cycloplegic eye drops + anti-inflammatory and vasotropic general medication [7-12]. In favorable cases, after 2 - 3 days of treatment, the anterior chamber (AC) becomes deep, the IOP rises to lower teens, and the air bubble floats again in AH. When the athalamia/hypotony syndrome lasts for more than 3-4 days, the partial air resorption allows the observation of SCD lobes. In cases maintaining athalamia for more than 7 days, the literature recommends the puncture in pars planum of SCD lobes, because after this interval the chances of synechial angle closure and of corneal complications significantly increase. The puncture is practiced by knife or diathermic needle. After the evacuation of SCD fluid, the AC is reformed with air, saline or, in modern days-with ophthalmic viscoelastic device (OVD) [10-12].

In my experience, the SCD after G surgery was not a benign complication. Between 1969 - 86, my procedure of choice in G surgery was Vancea T (VT) [22], a WEDPea extended on 120° (Figure 1). After 1979 I began to practice Cairns T (CT) [23], a "small fistula EDPea" (SEDPea), and after 1982 - the "trabeculo-keratencleizis" (T-K) [24], a "small but enhanced fistula EDPea"-a variant of CT in which the trabecular strip was not excised, but was detached on 3 sides, reflected over the thinned scleral bed, covered by the scleral flap and caught between 2 flap sutures (Figure 2). During that period, the incidence of postoperative SCD was 10.54% (37 cases after 351 EDPea): 11.55% after VT (26 out of 225 cases), 8.98% after CT (8 out of 89 cases), and 8.11% after T-K (3 out of 37 cases). The complication was always preceded by absent AC, with the air captured by iris bulge. The filtering bleb was absent or flat-after VT, and exuberant after CT and T-K. The eye was soft.

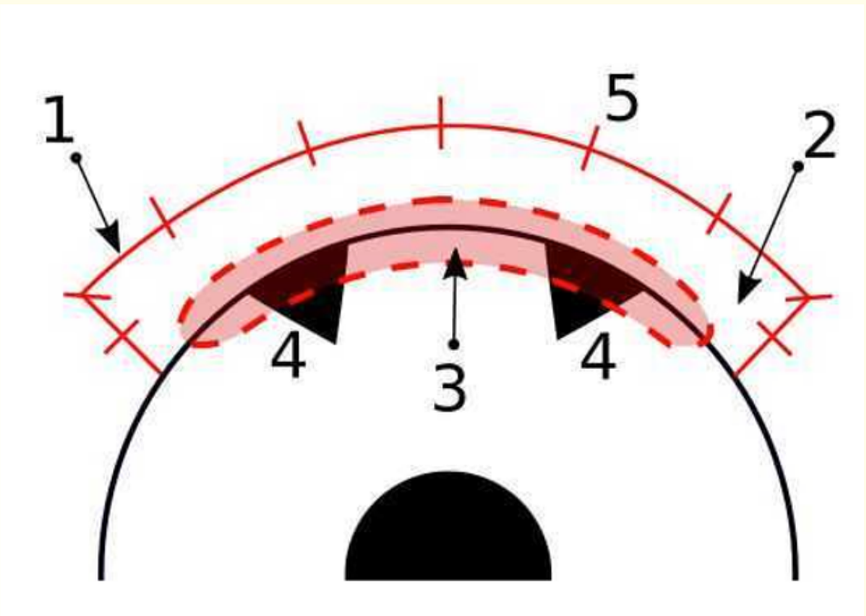

Figure 1: *Vancea enlarged trabeculectomy.*

The fornix based conjunctival flap and the traction suture under the superior rectus are not figured. 1: The incision line delineating the superficial scleral flap; 2: The superficial scleral flap; 3: The deep fistula after the excision of the scleral strip containing the trabeculum and Schlemm's canal; 4: Two peripheral iridectomies; 5: 9-11 separate flap sutures. The conjunctival flap is closed with 2 sutures at the limbus: when radial incisions have been added at the extremities of the conjunctival flap, each incision needs 1-2 additional sutures.

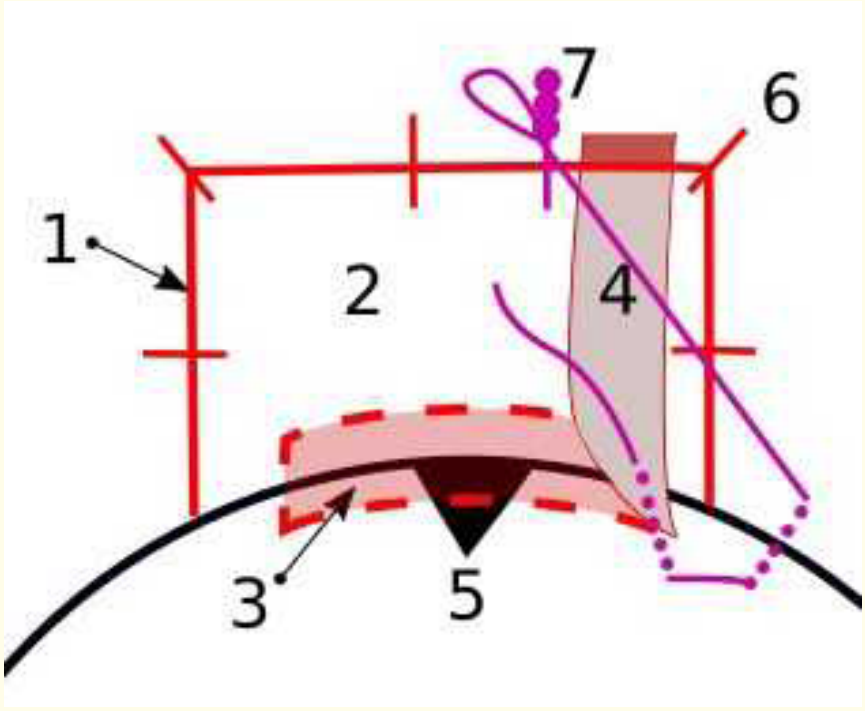

Figure 2: *The "trabeculo-keratencleizis".*

The fornix based conjunctival flap and the traction suture under the superior rectus are not figured. Usually the conjunctiva incision is "L" shaped, with one arm parallel with the limbus, and one arm – meridional. 1: the incision line delineating the superficial scleral flap; 2: the superficial scleral flap; 3: the deep fistula after tailoring on 3 sides the deep corneo-scleral strip containing the trabeculum and Schlemm's canal; 4: the deep corneo-scleral strip; 5: the peripheral iridectomy; 6: the flap sutures; 7: the releasable suture. Usually, the deep strip is caught between the left corner suture (6) and the releasable one (7). The conjunctiva is closed by one suture on flap corner and one suture on its meridional arm.

25 out of the 37 cases that developed SCD (67.57%) did not respond to medical treatment (17 cases after VT, 6 cases after CT, 2 cases after T-K). On the 7th postoperative day, I practiced the first surgery, consisting in the drainage of the most prominent SCD lobe: after "L" shaped limbal conjunctival incision with the meridional arm at 4 or 8 o'clock, a perforant scleral puncture was practiced in pars planum, at 4.5 mm from the limbus, on 5 or 7 o'clock meridians. The puncture was practiced a with diathermic needle (6 cases, operated between 1969 - 1972), or with razor blade fragment (19 cases, operated between 1972 - 1986). The AC was usually reformed with air until the iris-lens plane became slightly concave. The conjunctiva was closed with one limbal suture. The bed rest with binocular bandage, the antibiotic, anti-inflammatory eye drops, and the general vasotropic/anti-inflammatory treatment continued one day after the AC became deep and the air bubble freely floated in AH: this occurred after 1 - 5 days in 18 cases. One day later the patient left the hospital. The local treatment continued one month after SCD surgery.

Failure was noted in 7 cases. In these cases, the initial G surgery was VT (6 cases), or CT (1 case), and the first puncture agent was the razor blade fragment (5 cases) or the diathermy (2 cases). Despite ocular and general treatment continuation, with bed rest and binocular bandage, the situation did not improve. In the 3rd - 4th day, the air resorbed in part, and SCD lobes could be observed again. The second SCD surgery was practiced 7 days after the first one, and was addressed to both SCD lobes, the conjunctiva was opened in both inferior sectors. The previous scleral puncture was found closed. SCD lobes were punctured again, using the same instruments as for the first surgery: each

puncture drained yellowish SCD fluid. After the first puncture, the AC was reformed in part with air, to partially reform the tonus and to ease the second puncture. After the second puncture, the AC was reformed with the air slightly in excess, until the iris-lens plane became slightly concave. The conjunctiva was closed with one suture at the limbus.

From the 7 operated relapses, 2 cases relapsed again and needed the third surgery. In both cases, the initial G surgery was VT. The first case occurred in 1970 when all punctures were practiced with a diathermic needle. This case relapsed immediately after the second SCD surgery, and was operated 7 days later, both punctures were found closed and were practiced again (each drained yellowish fluid). The AC reformation with air followed the protocol used during the second SCD surgery. After 5 days of ocular and general rest, with antibiotic, anti-inflammatory, and mydriatic eyedrops, the case was cured. The second case, operated in 1984 for quasi-absolute trabecular glaucoma, relapsed at home, somewhere between day 6 after the second SCD surgery (when the patient left the hospital-apparently cured) and day 28 (when she returned to control). No filtering bleb was found-which was normal after VT, IOP = 16 mm Hg, complete athalamia, slightly hazy cornea, slightly opaque lens and no visible SCD lobes. New scleral punctures were practiced with razor blade fragment, and each puncture drained a small quantity of yellow fluid. Unfortunately, the AC was impossible to be reformed because the iris-lens plan adhered to the cornea on its whole surface. The separation had to be performed with spatula pushing back the posterior structures, the adherences were so strong that when the iris-lens plan was pushed posteriorly, the cornea became locally depressed. In the end, the AC was reformed with air. At the 6 months control, G relapsed and the cornea developed oedematous keratopathy.

Facing this situation that revealed the potential severity of postoperative SCD and having in mind the results of my previous studies [20,21] that suggested a direct communication between the AC and the supraciliary/suprachoroidal space in all long-lasting cases, I hoped to obtain better results with a more durable drainage of SCD lobes: this gave me the idea of "filtering puncture". The paper was presented in 1991 in Romania [20] but was not sent for publication. Now, after retiring, I consider that the paper maintains its interest.

Patients and methods

After obtaining the informed consent from the patients and the approval from the Ethics Committee of the hospital, I practiced the procedure described below (Figure 3) between 1986 and 1990, in 12 consecutive cases with postoperative SCD after advanced G surgery (VT-7 cases, CT-3 cases, TK-2 cases). Nine cases showed "primary trabecular G", 2 cases- "chronic primary pupillary G" and one case - a neglected attack of "secondary phacomorphic pupillary G". These terms were suggested in a pathogenic classification of glaucomas [26,27], that maintains the advantages of the gonioscopic classification, avoiding its disadvantages [28]. There were 7 women and 5 men, aged 58-88 years. The filtering puncture was practiced on the 7th day, after the failure of medical treatment.

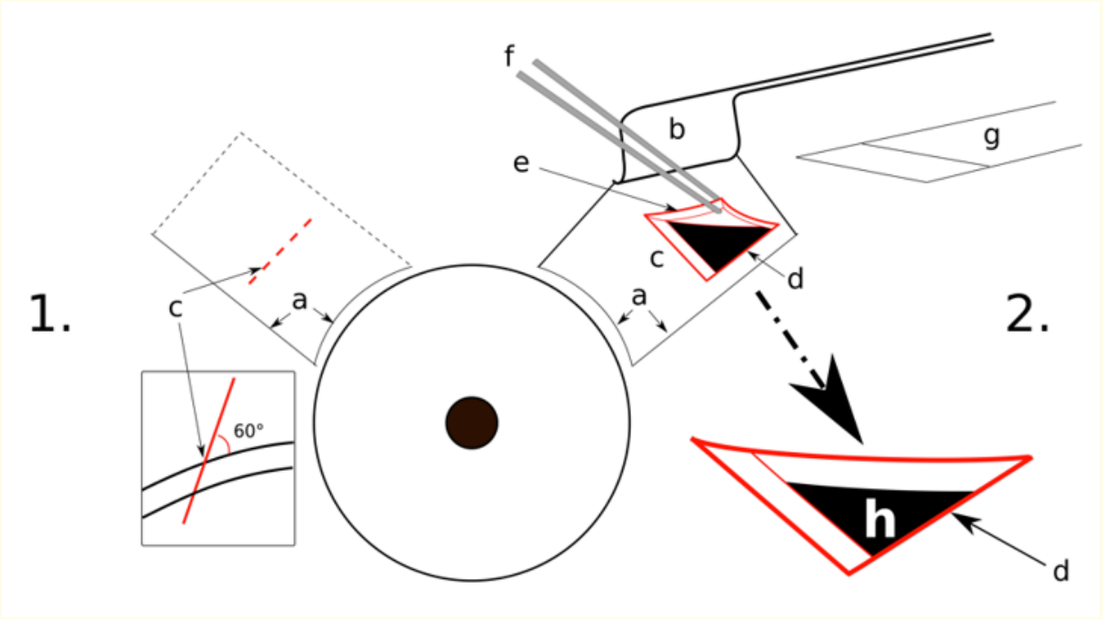

Figure 3: *The filtering puncture.*

1. The infero-internal filtering puncture: the conjunctiva incisions (a) and dissection (dotted lines); the first perforant incision on sclera, parallel to the limbus (c): in the box – incision angulation.

2. The infero-external filtering puncture: an iris retractor (b) maintains the conjunctival flap at distance; the second perforant incision on sclera, perpendicular on its surface (d), creates a scleral flap (e), which is raised with forceps (f), waiting for its apex excision with a cutting tool (g); the aspect after scleral flap apex excision, with the "uveal black" exposed (h).

Local anesthesia, akinezia, transconjunctival traction suture under the inferior and lateral recti.

Opening the corneal puncture left by the previous G surgery: I always begin any G surgical procedure with such puncture, in order (i) to slowly reduce the IOP before practicing the main maneuver; and (ii) to have a small and easy to close accessory entrance into the eye, other than the main wound). In case of postoperative SCD, I reopen that corneal puncture before creating the scleral incision/s, because after SCD fluid evacuation, it would have been more difficult to find the corneal puncture path on an extremely hypotonic eye. For puncture opening, I use a delicate spatula or 27G canula. In the end, I reform the AC with saline slightly in excess, and examine the T zone: if the filtering bleb dramatically increases, the over filtration can be dealt with transconjunctival sutures, or with direct scleral wound suture, preferably with releasable ones, after reopening the conjunctival wound: If the sickness is not cured, we may resume the rest of surgery after 2 - 3 days.

The conjunctiva approach: Two "L" shaped incisions, with the meridional arm placed at 4 and 8 o'clock, 7 mm long, and with the limbal arm from 4 to 5.30 and from 8 to 6.30 o'clock- respectively. The sclera was denuded in the angle formed by each of these incisions, and slightly beyond, on the dotted area. During all further maneuvers on sclera, an iris retractor for intracapsular cataract extraction created the space.

Thermal hemostasis of the sclera in each denuded zone.

The scleral punctures: Two perforant incisions were practiced at 4 mm from the limbus and parallel to it, on 5 and 7 o'clock meridians, 3 mm long each. To drain only when intended, and ensure comfort during practicing other maneuvers, these incisions were slightly oblique on sclera surface, to form a short valve. When each puncture was opened, the SCD fluid egressed, and the AC disappeared. This succession, occurred each time when the AC was reformed with saline and each puncture was opened, suggesting the existence of cyclodialysis and the need of a more durable drainage. The AC was reformed with air.

The filtering completion of each puncture: The posterior lip of each puncture was grasped with forceps and a perforant incision, 3 mm long, strictly perpendicular on sclera surface and on limbus direction was added at its right extremity, or at its left extremity-if the surgeon is left-handed. The apex of the resulting triangular flap was grasped with forceps, raised, and excised at the level of the remaining sclera, using a bent razor blade fragment, an angled knife or a pair of scissors. After resection, a triangular lack of substance remained, with the "uveal black" at its bottom. When the color was not intense black, the remaining deep scleral layers were grasped again with forceps and excised.

The AC reformation with air until the iris remained slightly concave.

Conjunctiva suture: Each incision was closed at 2 points: one simple suture at the flap apex and one "U shaped" suture on each meridional arm of the incision.

Results

At the first pansement, after 18 - 22 hours of bed rest with binocular bandage, the AC was found deep in all cases, the air bubble freely floated in AH, and the inferior conjunctiva was raised by a flat filtering bleb: this last sign was never observed after the simple SCD puncture. The superior filtering bleb showed a dramatic decrease, completely disappearing with normal IOP-after VT, and remaining moderate-after CT or T-K. The bed rest, with binocular bandage and general anti-inflammatory/vasotropic treatment immediately ceased, and the patients left the hospital on the 3rd day, with the indication to continue the antibiotic/anti-inflammatory and mydriatic eye drops for one month. The controls at 3, 7, 14, 21, 30 days, at 3, 6, 12 months and yearly-afterward, showed that the flat filtering bleb under the inferior conjunctiva disappeared in 3 - 7 days, and that 2 discrete dark spots remained as marks of scleral ablation sites. At the end of 6 - 12 months, these marks were barely visible. As for the very late results, no case developed ciliary staphyloma.

Discussions

1. My previous experience [20,21] proved that a direct communication between the AC and the suprachoroidal space always existed in the late phase of SCD after G surgery. This idea is strengthened by my present study: in all cases that needed surgery, the saline injected within AC rapidly outflowed through the scleral puncture, when opened.

2. The outflow speed of saline injected in AC through the scleral puncture suggests the existence of a wide communication, probably a cyclodialysis slit. My previous studies [20,21] could not establish whether this communication was the consequence of SCD lobes development (due to generally accepted exudation/transudation mechanisms), was generated by the surgeon, who pushed the excision beyond the scleral spur (the iatrogenic AH migration mechanism through cyclodialysis cleft/pores), or was the result of all 3 mechanisms (exudation/transudation/migration), associated or not with genetic weakness of iris root insertion.

3. The increased incidence of postoperative SCD after VT is probably explained by the fact that this technique favors unintentional cyclodialysis: the length of the excised strip (120°) increases the risk either of pushing the excision beyond the scleral spur or of weakening the iris root insertion [21]. This risk is counterbalanced by the fact that VT is the only external drainage procedure at the limbus in which the durable success is not accompanied by external signs of filtration. The pathogenic explanation of the differences found in the development of external signs of filtration after VT, CT, and T-K will be discussed later in tis paper, under # 5.10.4.

4. From the prophylactic point of view, my casuistry proved that the anti-inflammatory and vasotropic treatment was not able to prevent the SCD occurrence or relapse if applied alone. In my opinion, the risk of complication can be diminished only if the surgeon will observe the following:

- avoid pushing the trabecular excision beyond the scleral spur, the more that an old study [30] proved that the presence or the absence of trabeculum in the excised strip did not influence the pressure results.
- Close the scleral flap tight enough to prevent eye hypotony [6-12]. The releasable sutures [31-34], represent a perfect mean to avoid both eye hypotony and the excessive closure of T wound.
- At the end of the initial G surgery, fill the AC half with air and half with saline, to hasten the observation of SCD lobes and to avoid delaying the SCD surgery: I suggest this because my experience with VT shows that the duration of the athalamy-hypotony syndrome reduces the chances of success [29].

5. The treatment

5.1 My experience (Table 1) was not able to prove that the medical treatment recommended by literature had any effect in severe cases. It is true, in the first 7 days after G surgery, 12 cases (32.43%) had been cured, but 25 cases did not respond to medication, and needed surgery. The success rate of the first nonfiltering scleral puncture (unilateral) was 72%. After the second nonfiltering drainage

Criterion	Succes	Failure
Medical treatment	32.43% (15 cases)	67.57% (25 cases)
Surgical treatment		
Nonfiltering puncture: 1969 - 1986		
First SCD surgery (25 cases)	72.00% (18 cases)	28.00% (7 cases)
19 cases-with blade	73.68% (14 cases)	26.32% (5 cases)
6 cases-with diathermy	66.66% (4 cases)	33.34% (2 cases)
Second SCD surgery (7 cases), blade	71.42% (5 cases)	28.57% (2 cases)
Third SCD surgery (2 cases)		
1 - blade; 1-diathermy	50% (1 case: diathermy)	50% (1 case: blade)
Filtering puncture: 1986 - 1990		
12 cases, blade	100%	0%

Table 1: *The effectiveness of medical treatment, of non-filtering punctures and of filtering ones.*

episode (bilateral: infero-internal and infero-external), the success rate was almost similar, while after the third puncture (bilateral, too) it decreased to 50%. The puncture instrument (diathermy or blade) did not influence the success rate.

The fact that after the first surgery (when only the most prominent SCD lobe was punctured) 28% of cases relapsed, might suggest the idea that the unilateral puncture was not enough. The fact that approximately the same percentage relapsed after the second surgery (when both sides were punctured), might suggest that the number of punctures may not be important.

5.2 Facing this confusing situation, I supposed that **the duration in time** of SCD drainage might have more significant consequences. I was aware that sooner or later, any SCD puncture will close, because the local conditions favor this evolution: the SCD fluid-generated (primarily or secondarily) by exudation/transudation/migration mechanisms-is full of fibrin precursors; the surgical trauma in the zone of SCD puncture (tissue cuts, dissections, burns, crushes, wipes, perforations) causes cell destruction that will free the necessary enzymes from cell micro-organites. Consequently, fibrin formation and deposition will be stimulated in the suprascleral space close to SCD puncture and will block it.

However, if the puncture/s closure appears too soon (before both the ciliary secretory shut down and the associated inflammatory process are solved), the SCD lobes could reform. As for the intimate mechanism of cyclodialysis persistence, I opined that the lobes themselves would induce tensions in the choroid-ciliary body membrane, that could maintain the cyclodialysis cleft/pores open [21], and would produce sickness relapse, even when only one component of the triple loop pathogenic mechanism is active: the communication between the SCD lobes and the AC could reheat the other two.

5.3 How long should the SCD drainage last?

The second day after any classic, nonfiltering SCD puncture I did not observe any bleb formation in the conjunctiva above the puncture site: this proves that the drainage through a simple scleral puncture lasts less than 24 hours, especially when it is slightly oblique and creates a valve. Even without this obliquity, the simple puncture can be easily closed by its margin's hydration. For me, this early closure explains at least in part the SCD relapse after nonfiltering punctures.

As for the question "how long should the SCD lobe drainage last in order to prevent the relapse", the answer is as imprecise as possible: as long as necessary to interrupt every component of the triple loop pathogenic mechanism. The literature [6-12] incriminates hyperfiltration through T wound with eye hypotony, as the main mechanism. If in this situation, the main outflow could be derived through an alternative pathway for several days, the T wound will have the possibility to partially close and resume its readjusted function when the ciliary shut down will cease. For that, the alternative pathway should be direct and imply smaller outflow resistance than the one of the T. The literature [6-12] incriminates also the hyposecretion mechanism resulting from ciliary tissue distortion produced by SCD lobes: to address this mechanism, the drainage of SCD lobes should be quick and complete. My previous studies [20,21] proved that ciclodialysis always existed at 7 days after the beginning of athalamia/hypotony syndrome. To close it, the drainage should ensure a continuous contact between the torn iris root and the sclera for several days, to allow the beginning of scar formation.

All these conditions are completely fulfilled by my filtering puncture.

On the other hand, "as long as necessary" does not mean "too long", because "too long" could induce the complete closure of T wound. I suppose that the safe duration of the alternative pathway is between 7 and 14 days, because the literature recommends that the puncture of SCD lobes be practiced after 7 days of medical treatment [4-12], and that the releasable sutures be ablated 7 - 14 days after G surgery [31-34]. These data mean that the T wound is not closed at 7 - 14 days after surgery.

5.4 The timing of filtering puncture

I respected the timing recommended in the literature and performed the filtering punctures after 7 days of failed medical treatment.

Against this timing plea 2 practical findings: (i) The negative influence of SCD duration on late results after VT; [29] (ii) The risk of life-threatening complications in debilitated patients [35] submitted to prolonged bed rest with a binocular patch. As far as I am concerned, I lost one patient, 88 years old, operated on his only functional eye, the last patient who developed SCD after G surgery before my retirement. He refused SCD surgery and passed away after 8 days of bed rest with a binocular bandage, despite the prophylactic treatment with vasoprotector and anticoagulant agents.

After this case. I decided that **Sooner the vicious pathologic circle of SCD is broken, the better:** I decided that any future case will be drained the second day after the observation of SCD lobes. No SCD case occurred till my retirement, but in my private practice, in the informed consent for G surgery, I included a point about postoperative SCD, insisting that the surgical sanction must be applied the second day the positive diagnosis is established. I do not have high resolution ultrabiomicrospopy (HRUBM), but if I would, I'd practice the filtering puncture as soon as the SCD is observed.

5.5 The fact that the success rate of **classic punctures** was not influenced by **the way they were practiced** (by knife or diathermy) suggested me that what the diathermic drainage gained in fistula dimension (the thermal tissue destruction/retraction creates a larger hole), was lost by inflammation increase. That is why I supposed that practicing the filtering puncture by blade will favorably influence the evolution: The supposition was confirmed by my casuistry.

5.6 The number of filtering punctures: Logically, the evacuation is more rapid and complete through 2 drainage sites situated each in the close vicinity of one SCD lobe, than through a single puncture situated at a great distance of at least one lobe. From a practical point of view, I practiced the filtering puncture on both sides (infero-internal and infero-external) in all 12 cases, because the simple puncture released fluid on both sides. More than that, my previous experience proved that the unilateral drainage was followed by a relapse in around 1/3 of cases. As a rule, I think any simple puncture in pars planum that produces egress of clear, yellowish fluid should be completed as a filtering one. This simple and riskless gesture could prevent the completion of the pathogenic mechanism with the "migration" component, that would prolong the sickness.

5.7 The site of filtering punctures. I practiced the filtering punctures in pars planum because this was the site recommended in literature [6-12]. As the results were excellent, I don't think that the subject deserves further efforts.

5.8 The efficiency of filtering punctures was proved by the development of a flat filtering bleb under the inferior conjunctiva, lasting for several days. In the consulted literature, I did not find notes about the development of filtering blebs over simple or diathermic punctures of SCD lobes.

5.9 The air in AC was injected at the end of the procedure, and slightly in excess until the iris/lens membrane becomes slightly concave. As such, the air bubble played an active role, inducing the firm contact between the 2 raw surfaces (the iris root and the sclera). I am against the use of OVDs, especially of the dispersive ones, because they maintain open the space between the 2 raw surfaces and delay the closure.

5.10. The risks

5.10.1. The immediate risk of chorioretina rupture in the zone of scleral ablation is nonexistent: no case developed this complication. In the same sense pleads the innocuity of the wide "Z shape" perforant scleral incisions (4/10/4 mm) practiced in case of expulsive hemorrhage under the horizontal recti (Figure 4a) and left not sutured-in order to prevent expulsion relapse in case the hemorrhage

relapses [36,37]. All 6 cases were saved with good or useful vision (BCVA 6/9 - 6/36) and round pupils. No case developed early chorioretinal rupture in the incision zone, not even the case in which the expulsive hemorrhage relapsed in the nasal sector, 5 hours after being drained in the temporal one; in the morning, after 18 hours of pain and high IOP, I explored the zone of the "Z" shaped perforant incision in the temporal sector: I found the scleral wound slightly gaped on 2 - 3 mm (Figure 4b), with the chorioretinal membrane slightly bulging through the zone nonprotected by sclera (3/10 mm), under the external rectus muscle, on a rock-hard eye. I drained the nasal blood collection using the same wide Z-shaped scleral incision practiced under the internal rectus muscle, and the wound gape disappeared. In the

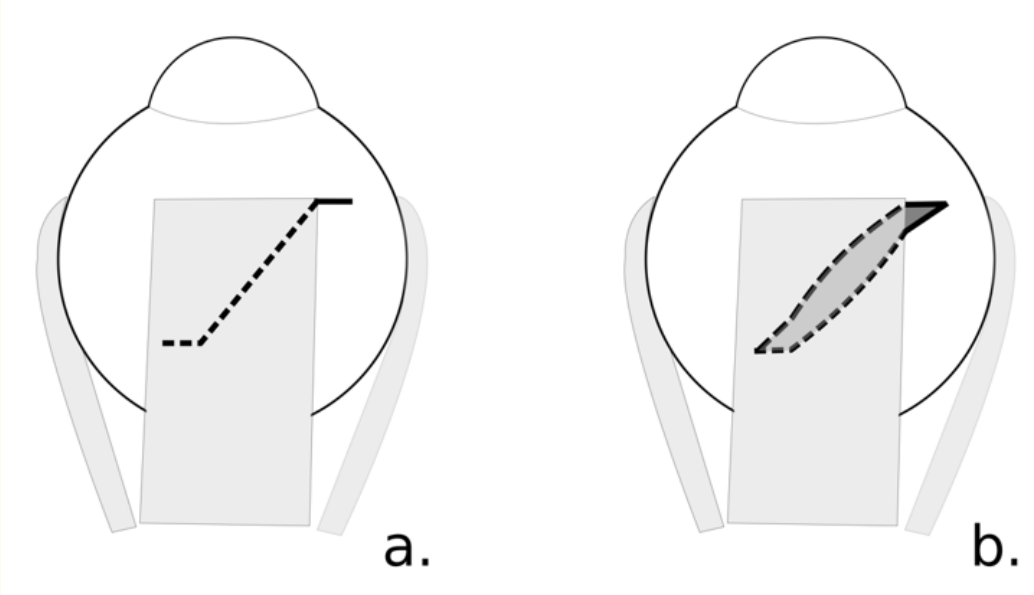

Figure 4: *The wide, "Z" shaped, perforant incision for expulsive haemorrhage. a. The wide scleral incision compared with the temporal horizontal rectus muscle and with the contact arc of that muscle. b: The aspect after 18 hours of intense hypertony caused by haemorrhage relapse in the nasal sector of the eye.*

end, everything went uneventfully. This extreme case suggested to me that without additional trauma, the chorioretinal membrane can withstand alone an ocular hypertony that equals the systolic pressure in the arteries that irrigate it. I wrote "the systolic pressure in the arteries that irrigate it" because the IOP cannot spontaneously exceed the systolic pressure in the arteries that irrigate the eye, no matter if the ocular hypertony is generated by hydrodynamic (aqueous outflow block) or hemorrhagic (expulsive hemorrhage) mechanisms. This last case proved that without additional trauma, the immediate risk of chorioretinal membrane rupture in the zone of wide scleral ablations is nil. The risk is even smaller in the case of small scleral ablations like the ones generated by the filtering punctures.

5.10.2. The risk of developping long lasting filtering blens in a risky, nonprotected by eyelid area.

This risk is also nil because as soon as the SCD fluid is drained, the filtering puncture is blocked by the continuous choroid membrane that exists beneath. None of my 12 cases developed chronic filtering blebs over the filtering punctures in the inferior sectors of the eye.

5.10.3. The risk of T closure

At the first sight, the creation of an alternative, easier drainage pathway through the filtering puncture of SCD will diminish the amount

of fluid circulating through the T wound and will increase the risk of its closure, because the fistula must be circulated if we want it to last.

However, if SCD complicates G surgery, I think that it is better to avoid fluid circulation through the T wound as long as this fluid has pathologic content that could block the T fistula. Or, during SCD, the AH is full of fibrin precursors generated by hypotony/inflammation mechanisms. If we would allow this pathologic AH to infiltrate the subconjunctival tissue close to T area, it will meet in that area the necessary enzymes freed from the surgically destructed cells, and fibrin deposition + scar tissue formation will be enhanced. That is why, in athalamia/hypotony syndrome after EDPea, smaller will be the quantity of pathologic AH circulated through the T fistula in the first postoperative days, the better. On the contrary, the drainage of this pathologic AH at a great distance from T area would increase the T chances of success.

In fact, the alternative pathway cannot last too long: After breaking all pathogenic loops, the filtering puncture will spontaneously close because it will be blocked by the continuous choroid membrane beneath. On the contrary, the membrane beneath the T fistula is perforated by 1 - 2 peripheral iridectomy/ies, so that all chances exist that the T fistula lasts longer than the filtering puncture.

5.10.4. The impact upon further G surgery

G may relapse even after uncomplicated surgery in 20 - 30% in 5 years [7,12], and may need iterative surgery. Owing to financial reasons, the iterative surgery will frequently use external drainage, T-like G procedures, based on filtering bleb development. Clinical experience has stated that in this group of procedures, the success rate is greater when performed on intact conjunctiva [7-10,38,39]. That is why, each surgery should limit the negative collateral influences, because nobody knows which case would relapse. These negative influences could be grouped into three levels.

1. The conjunctiva: The area of conjunctiva dissection determines the size of the initial receptacle where the enzymes freed from the micro-organites of the surgically destructed cells will accumulate and combine with the early AH-rich in fibrin precursors (see the early phenomena discussed under # 5.2). The size of this receptacle determines both the concentration of this "fibrinogenetic soup", and the size of filtration bleb;

2. The scleral flap: The degree of distortion induced within scleral flap during its suture is responsible for:

    - Misalignment of flap margins within scleral bed, with the formation of few larger fistulas instead of a filtration through tiny pores equally distributed along the incision length: thus, chances of athalamia increase;

    - Stretching lines in the flap: this will misalign the cut ends of Schlemm's canal emissaries, that will not have the chance of connecting themselves by endothelial proliferation with the episcleral venous system, in a continuous intravascular drainage pathway, but will be closed;

    - Early tissue cut by sutures: this will further concentrate the filtering points in large fistulas

3. The angular size of surgery zone: This size determines the number of interventions that fit in the election area for filtering bleb formation, covered by the superior lid.

All these influences produce differences in filtering blebs dimensions, both in SEDPea and in WEDPea.

A/ SEDPea (CT or T-K). In uncomplicated cases: (i) The conjunctiva is dissected only on a small area around the future scleral flap. In this small poach the concentration of fibrinogenetic soup is high, the scar formation effect is maximal on poach internal surface, altering the resorption capabilities of the tissue, so that in the end, the resorption capability per unit of surface will be limited; (ii) The degree of distortion in this short scleral flap during suture is high and the filtration will take place through few larger fistulas along flap margins, with only a few direct intravascular drainage points on scleral flap surface, starting from the cut ends of Schlemm's canal emissaries; (iii) The advantage of this group of procedures is that in the election zone for filtering bleb formation (covered by the superior lid), three surgical sessions can be performed on practically "virgin" conjunctiva. The filtering blebs will usually accompany the success.

When the evolution is complicated by SCDs-treated according to the existing protocols, the filtering bleb is exuberant in the first postoperative days, covering the whole superior conjunctiva, far beyond the surgery site. In the case of iterative surgery, I found the whole conjunctiva that hosted the early exuberant filtering bleb slightly thickened, more rigid, and even retractile, when the iterative surgery lasted too long and we did not use measures to counterbalance the retraction of the dissected conjunctiva during a too long surgery. In my opinion, this happened precisely because, in the first 7 postoperative days, the existing protocols allowed the accumulation of abnormal

AH in the space under the dissected conjunctiva, above the T site, in a space already soaked with enzymes freed from the surgically destructed cells. Due to the fact that the internal cohesive structures within the rest of the subconjunctival tissue are weak, this "fibrogenetic soup" will infiltrate the subconjunctival tissue far beyond the dissected area, and will transport there a part of its fibrinogenetic content. The slight pressure induced by the superior lid margin upon the closed eye maintains this fibrinogenetic soup mostly in the zone covered by the superior lid, which -unfortunately- is the election zone for filtering bleb development. This means that after EDPea complicated by SCD and early exuberant filtering blebs, even if one would practice the iterative surgery in a zone untouched by surgical instruments, but still under the superior lid, one will not work on intact, "virgin" conjunctiva, and the chances of success will be diminished. To avoid this evolution, the abnormal fluid content of SCD lobes must be drained in a zone situated at a distance from the area covered by the superior lid: with this respect, the infero-nasal and the infero-temporal sectors-being useless for EDPea procedures, are the best candidates for discharge sites.

B/ WEDPea" (VT). In uncomplicated cases, these negative influences are much limited because usually, the success is not accompanied by early or late filtering blebs. In my opinion, this unusual behavior for a filtering surgery is explained by the surgical protocol. (i) The conjunctiva incision at the superior limbus on 160° is continued by opening of the superior Tenon space on both sides of the superior rectus, for its identification and passage beneath of a 5/0 silk suture, to facilitate eye displacement and fixation in the best position, during the dissection of the 120° long scleral flap; due to the wide opening in the Tenon space, most of the exteriorized early AH will freely spread in this space, and the quantity remaining for resorption in the anterior conjunctiva will be insufficient for early filtering bleb formation; (ii) The closure of this very long flap (120°) generates less tissue distortion: instead of being evacuated through one or few larger fistula/s resulting from flap/bed incongruences and from early tissue cut in front of some sutures, the AH is distributed over a wide surface through innumerable tiny filtration pores distributed along the 20 mm long flap margins and through the cut ends of Schlemm's canal emissaries. Many of these cut ends will remain open in this undistorted long flap and will be able to connect themselves with the episcleral venous system via endothelial proliferation. Consequently, less AH will remain to be resorbed by a certain amount of subconjunctival tissue via transparietal pathway, and the durable success will not be accompanied by filtering bleb formation. (iii) These advantages are partially annulled by the fact that in the zone protected by the superior lid only one VT can be performed.

In cases of VT complicated by SCD, the early filtering bleb remained flat or absent, because of the phenomena discussed above, under # (i) and (ii). During subsequent surgery, I found an almost normal conjunctiva, meaning that the theoretical chances of successful iterative VT in the same zone are not altered, unlike in the case of CT and T-K complicated with SCD. However, I found that SCD had negative influences upon the late pressure results of VT [29], probably because the tiny filtration pores are more easily closed in time than a large fistula. This shortcoming together with the extreme difficulty of performing iterative VT-like procedures at the superior limbus made me renounce to VT as an election procedure in G. Now, VT is reserved only for cases with completely scarred superior conjunctiva. As the durable success is not accompanied by filtering bleb formation, it may be practiced on exposed zones of the limbus, as a cheaper alternative, more durable and implying less corneal risks than the tube shunts.

The conclusion of this pathogenic analysis indicates that in the case of SCD complicating EDPea, the abnormal SCD content must be drained elsewhere, at distance from the therapeutic fistula. Anyhow, to cover any surprise in iterative EDPea, it is wise to associate fibrosis inhibitors [38, 39].

5.10.5. The late risk of scleral ecatsia in the zone of filtering puncture: no case developed this complication after 15 - 30 years of follow-up. Moreover, no case developed scleral ectasia in the zone of wide "Z-shaped" scleral incision left unsutured, to solve the expulsive hemorrhage (see 5.10.1) It is true, none of those cases developed glaucoma.

5.10.6. The risk of long duration, intense hypotony with fundus consecutive alterations, has never occurred in my casuistry, in which the filtering punctures had been practiced 7 days after G surgery. From a logical point of view, as soon as the SCD disappears, the

ciliary body is supposed to resume its normal function. As for the remaining over-filtration, it has already been cured by the scarring process that followed the infiltration of plasmoid AH in the conjunctiva over the T area in the first postoperative week.

5.10.7. What other instruments can be used for filtering puncture: The 1 mm scleral punch could be the perfect alternative for manually bent razor blade fragment, or for any slit or crescent knife: the maneuver would be much simpler, through a smaller scleral incision, without the need of the second, perpendicular one.

5.10.8. In what other pathology could this procedure be used?

I think that the filtering puncture can also be used in traumatic cyclodialysis. If absent, the peripheral iridectomy will be added at distance from the cyclodialysis site in order to prevent the inverse pupillary block; then, one filtering puncture at 4 mm from the limbus on cyclodialysis meridian + air (not OVD) within AC until the lens-iris plan becomes slightly concave + double row transscleral diathermy at 1,5 and 2.5 mm behind the surgical limbus over the cyclodialysis cleft. This procedure could be much simpler and less risky alternative than the real ciliary body-sclera suture [41,42].

Further developments

The findings of this study can be developed by enthusiastic ophthalmologists in at least 10 new research lines, because I have already retired.

1. What is the influence of filtering puncture on SCD evolution, if practiced in more cases, in the 7th day of the athalamia/hypotony syndrome, according to the protocol described in this study?
2. Is the filtering puncture associated with full mobilization of the patient able to cure the complication, if the simple puncture - practiced in prophylactic manner, early (before the observation of SCD lobes), in all cases with athalamia/hypotony syndrome - would drain yellowish fluid?
3. What is the best timing for filtering puncture? Is there a justification for practicing the filtering puncture in athalamia/hypotony syndrome before the observation of SCD lobes?
4. What is the effect of one single filtering puncture? I practiced filtering punctures in both inferior quadrants because both simple punctures produced fluid egress when opened, and because my previous experience proved that one puncture produced relapse in almost 1/3 of cases. But those punctures were nonfiltering ones. What if one single filtering puncture is enough?
5. What is the influence of filtering puncture site upon SCD healing speed?
6. What is the efficiency of filtering puncture in SCD after cataract surgery, compared with the efficiency of a simple or diathermic puncture?
7. What is the best timing for filtering punctures in SCD occurring in nonsurgical cases?
8. Which agent injected within AC (air or OVD) produces the best results?
9. What is the effect of practicing the filtering puncture with scleral punches: which is the best dimension of scleral ablation?
10. Could the traumatic cyclodialysis be cured by the procedure suggested under # 5.10.8 of this paper?

The answer to these questions will prove that the research lines suggested both in my previous paper [21] and in the present one are not experimental surgery, but have a clear curative purpose:

(i) my study has proved that the filtering puncture practiced at 7 days after surgery cured all case with athalamia/hypotony syndrome after G surgery on which it was practiced. If further studies would prove that it can cure all cases, even when practiced before the observation of SCD lobes (2-7 days after surgery), the period of bed rest and binocular eye bandage, with its inherent risks for patients suffering from life-threatening pathology could be significantly shortened;

(ii) my previous experience proved that the filtering puncture is a riskless procedure. If this riskless procedure would cure the complication, the bed rest + binocular eye bandage and their risks could be completely expelled from SCD therapeutic armamentarium.

Attention

Anytime the filtering puncture is to be practiced on non iridectomized eyes, the peripheral iridectomy must be added, to prevent the inverse pupillary block that may appear when the AC is reformed with air.

Each of these questions may justify original research conducted by young and enthusiastic ophthalmologists. Some of these projects will need the approval from the Ethics Committee of the hospital.

Conclusion

- The study confirms that in the late phase of SCD after T, a direct communication between AC and SCD lobes exists, being either the cause or the consequence of SCD lobes development.
- The pathogeny of postoperative SCD is based on a triple loop vicious circle (transudation/exudation/migration), with the possible influence of genetic factors, any of these pathogenic components may trigger the other two and prolong the sickness.
- The filtering puncture promptly cured all 12 cases that entered the study. The new procedure eliminates the risks of prolonged bed rest with binocular patch.
- The present study suggests 10 original research lines, to be further developed by young and enthusiastic ophthalmologists.

Conflict of Interest

None.

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