EC OPHTHALMOLOGY
Research Article

Micro Perforating Deep Sclerectomy, A Modification of Non Penetrating Deep Sclerectomy

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Glaucoma is one of the main causes of blindness in the world, and its incidence, in morbidity, as in number of blind patients, is on the rise [1], despite improvements in technology for the diagnosis. The main problem is that 80% of glaucoma [2], are of open-angle, which is characterized by the absence of symptoms until advanced stages, in which the clinical treatment is not sufficient, and surgery must be indicated, for adequate control of intraocular pressure [3].

There are several surgical techniques described for the treatment of glaucoma, however since its description in the 1960s, trabeculectomy described by Cairns [4], has remained with few modifications as the gold-standard technique in the surgical management of Glaucoma. It is a technique practiced around the world, from sub-specialized, to residents in training ophthalmologists, since it has a relatively low learning curve [5]. However, despite continue to show very good results, even comparing it with drainage implants "valved" or not [6], the complications risk rate, is still relatively high, mainly during the postoperative, and related to ocular hypotension (choroid detachment, hypotonic maculopathy, corneal folds) or fistula communication with the environment (endophthalmitis, blebitis, Seidel) [7-9].

In the mid-1990s, non-penetrating glaucoma techniques were described [10], which employed the pathophysiological theory, that the area of greater resistance to the exit of the aqueous humor is located in the external wall of the Schlemm's canal [11]. This wall is removed, keeping the inner wall, which allows a controlled and low flow out through the trabecula and the inner side of the canal still present, what was called, Descemet's trabecular membrane [11,12].

The technique of this surgery was indicated for open-angle glaucoma, in which they made a well wide fornix-based peritomy, mild coagulation, to avoid contraction of the tissue, and then proceed to the carving of a first surface flap (1/3 of the scleral thickness) of approximately 4 x 4 mm, which must get to the limbo and enter slightly into the clear cornea (Figure 1). Then, at this point, it is recommended to perform a paracentesis in anterior chamber, to reduce the intraocular pressure. Then, a second thicker inner flap is carved, which should cover all the scleral thickness, up to the pre-choroidal level of approximately 3 x 3 mm (Figure 2). This flap must dissect gradually forward, where at limbo level there will be the transition zone from the change of direction of the scleral radial fibers, to the transverse fibers of the scleral spur. The carving must follow in that plane up to the clear cornea, with the exposure of the Schlemm's canal, and arriving at the Schwalbe's line Figure 3. Once these structures are identified, there is the removal of the external wall of the Schlemm's canal, which is characterized by being a dark and erectile tissue band, immediately after the change of direction of the scleral fibers Figure 4. When removing this tissue, the aqueous humor exit can be seen through this unroofed channel. Subsequently, the second flap must be cut, which will leave this intra-scleral space empty, and it will work as a decompression chamber Figure 5, and the first flap is sutured with loose and hidden stitches, to then make the airtight closing of the conjunctiva.

This surgery was developed searching for a procedure that respects the integrity of the anterior chamber, with a good blood pressure lowering effect and a safety margin greater than that of the conventional trabeculectomy [13], in order to avoid a sudden decompression, an uncontrolled exit of aqueous humor, and the formation of high filtration blebs [14]. However, it never really reached peaks of popularity, mainly due to the technical difficulty that means to develop it as a routine, without it meaning to increase significantly the surgical time, or the risks of complications [15].

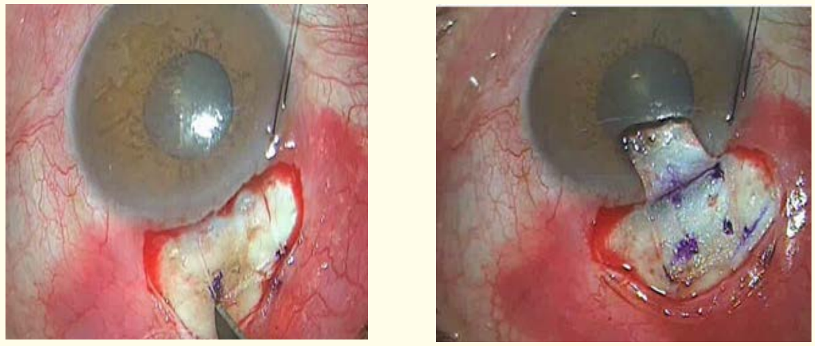


Figure 1: *Carving of the superficial scleral flap.*

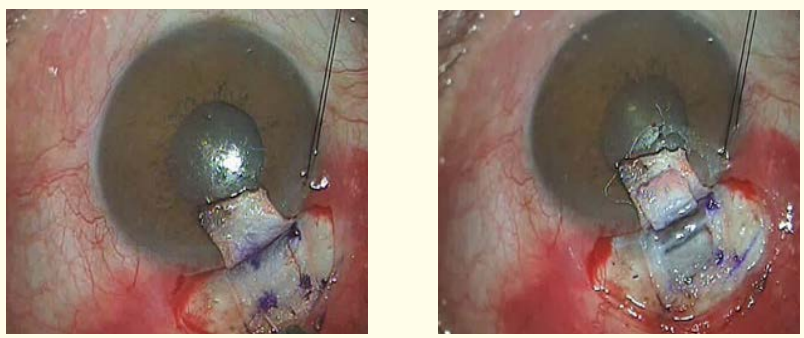


Figure 2: *Carving of the second-deep scleral flap.*

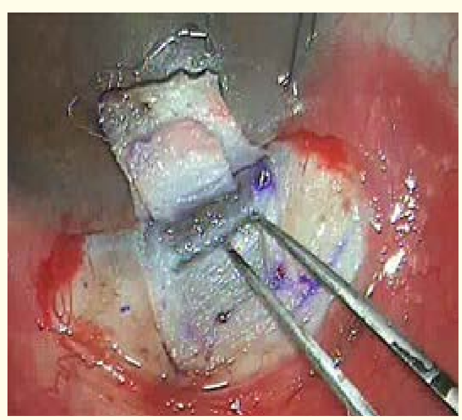


Figure 3: *Exposure of Schlemm´s Canal.*

Figure 4: *Removal of External wall of Schlemm´s Canal.*

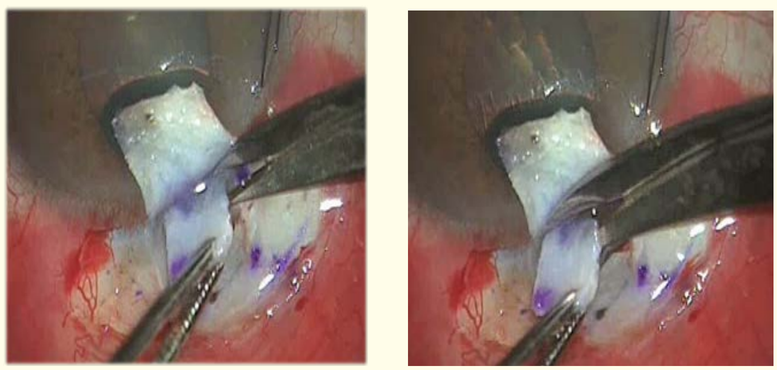


Figure 5: *Removal of deep Flap.*

The technical difficulties are basically to identify and reach the ideal plane of dissection of the second level, at the limbo level, since a layer of very thick pre-choroidal scleral tissue will avoid reaching the level of filtration, making surgery useless without hypotensive activity, which caused that the ophthalmologist, should go back to the operating room to turn the surgery into a conventional trabeculectomy, or thin the flap, up to the appropriate level of surgery, this being a second procedure, with greater risk of conjunctival lesion, or excessive scarring. But also there is also the risk of advancing very deeply in the plane, and perforating the wall of the Schlemm's canal, breaking the so-called Descemet's trabecular membrane, which causes a spontaneous conversion into a trabeculectomy, with the added problem of keep containing the operation a thinned scleral plane, with an ostium of great caliber, which causes greater risk of complications related to ocular hypotension [15].

Facing these technical difficulties, we developed a modification to the Deep Non-penetrating Sclerotomy (DNPS), which we called Deep Microperforating Sclerotomy, in which, following them same steps and indications of the DNPS, we performed the conjunctival peritomy, carved the first surface flap, and carved the second flap, coming to the pre-choroidal plane. In this step, when advancing in that plane, towards the clear cornea, one may accidentally pierce and communicate the anterior chamber to the outside, and must convert to trabeculectomy, or one leaves a very thick residual scleral tissue layer that prevents the function of filtration of the formed membrane. At this point, after having made a paracentesis of the anterior chamber, and the application of Mitomycin C at 0.02% for 2 minutes, we performed micro punctures in the membrane formed, with a 30G needle (Figure 6). We performed between 5 and 10 punctures, depending on the integrity and rigidity of the meshwork formed, and of the amount of aqueous humor that exit through the punctures. Once the permeability of this Descemet's trabecular meshwork is confirmed, it is routinely performed the suture the flap surface and the conjunctiva. Occlusion with antibiotic ointment is maintained for 2 to 5 days (depending on the closure of the conjunctiva at limbus level and the presence or absence of Seidel) [16,17].

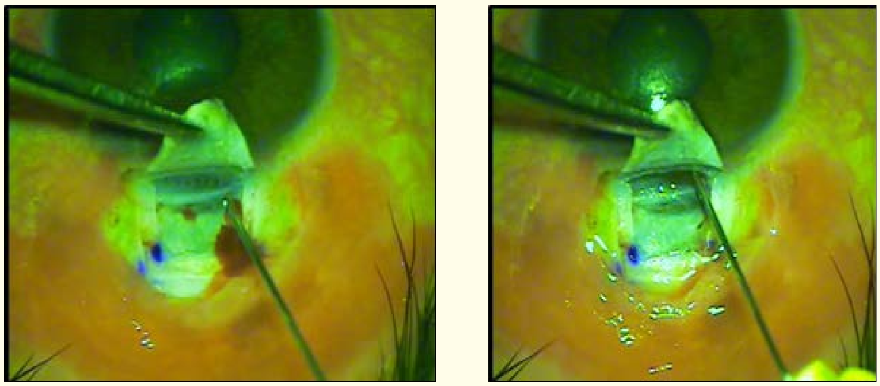


Figure 6: *Microperforations of Trabeculo-Descemetic Membrane with 30g Needle.*

Figure 7: *Ultrasound Biomicroscopy showing the persistance of trabeculo-descemetic membrane resistance, and the Microperforations permeability.*

The aim of this modification is to create a mesh or Descemet's trabecular network covered by a thin layer of corneal or scleral tissue that allows an active flow of aqueous humor, but with a certain degree of resistance (Figure 7), allowing the reduction to be controlled, avoiding the risks of the surgery of full-thickness, related to hypotonia and athalamia. This allows the developing ophthalmologist to gain experience in non-penetrating surgery, avoiding the complication of accidentally convert into a great trabeculectomy or not to reach a proper filtration level. The surgeon will eventually gain experience and obtain a technically correct DNPS, but even so, the option of micro puncturing the membrane, improves the final blood pressure lowering effect of non-penetrating surgery, with an identical security parameter [16,18].

Method

A retrospective study of patients undergoing Deep Microperforating Sclerotomy surgery was carried out with Open Angle Glaucoma diagnosis (Primary, Pseudophakic, Pseudo exfoliative) and follow-up of more than 2 years. They obtained 58 eyes in 49 patients, aged between 46 and 80 years. 34 eyes had the diagnosis of primary open angle Glaucoma, and 24 eyes were Pseudophakic or with pseudo exfoliation capsular lens syndrome (or both). It was taken into account the preoperative intraocular pressure, number of medication pre surgery, post-operative intraocular pressure to the first month, 6 months, 1 and 2 years of follow-up, number of post-op drops, need of new procedure, intra or post-surgical complications. We considered success with post operation Intraocular pressures of 18 or less, and no progression in Optic nerve head Ocular Coherence Tomography, or visual field tests.

Results

58 eyes from 49 patients from 46 to 80 years of age. 34 eyes with dx of gaa, 24 eyes with Pseudophakic glaucoma. During the years 2010 and 2014, all of them went under DMPS surgery and it was controlled for 2 years. The patients showed previous intraocular pressure between 20 and 32 mm hg, with use from 0 to 3 drugs (Figure 7).

Number of Antiglaucomatous Eye Drops Used Pre and Post Mpds		
	PRE MPDS	POST MPDS
EYEDROPS	2,17	0,39

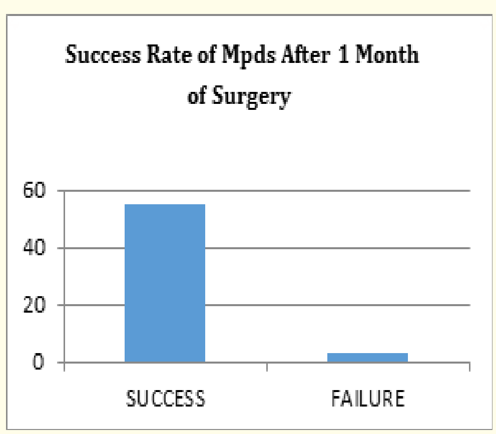
Figure 7: *Number of Drugs needed before surgery and in next controls.*

All the cases showed glaucomatous damage in the computerized visual field, confirmed in 3 studies, and correlative damage in tomography of optical coherence of the optic nerve head and the nervous fiber layers of the macular area.

The surgery decision was based on not reaching the Target IOP, on the confirmation of damage progression despite the treatment, or on the impossibility to add more medication (medical contraindication, patient's refusal, intolerance and adverse reactions).

All the procedures were carried out by the same ophthalmologist surgeon, and controlled at the Glaucoma center in our institution. Then, data were collected and it was considered a success from the surgery to have obtained post operatory intraocular pressure of 18 or less mm hg.

Upon the first follow-up month, it can be seen that the post-surgery intraocular pressures are between 12 and 22 mm hg and the success was achieved in 55 patients and only 3 patients who did not get figures lower than 18; so their treatment was restarted with mono-drug (analog of prostaglandins). However, there was not any symptoms of hypotonia, athalamia, choroidal detachment, hyphemia, or myopic maculopathy. There were although 10 cases with Seidel + which were solved by compressive bandage and antibiotic ointments (Figure 8).



Success Rate of Mpds After 1 Month of Surgery	
	Patients
Success	55
Failure	3
MPDS: Microperforating deep sclerotomy	

Figure 8: *Success rate after 1 month follow up.*

Upon 6 months' control, IOP control showed data from 50 eyes that had stable intraocular pressure without the need of medication and only 8 eyes using a drug to control pressure (Figure 9).

Success and Failure of Mpds After 6 Months of Surgery	
	Patients
Success	50
Failure	8
MPDS: Microperforating deep sclerotomy	

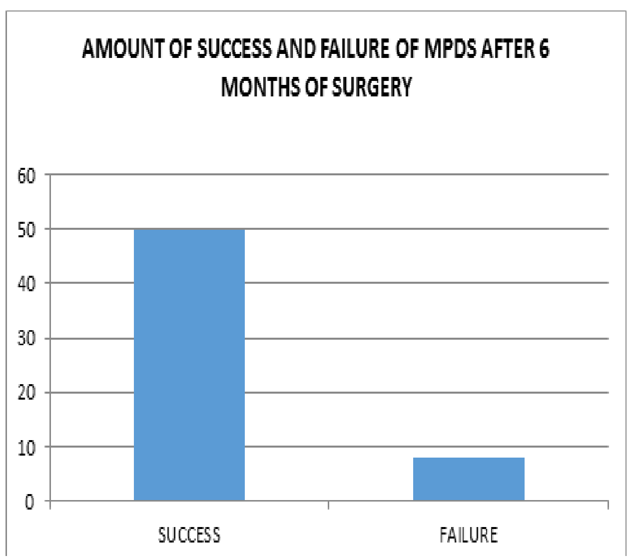


Figure 9: *Success rate after 6 months follow up.*

After the first year control, 43 patients kept good control and stability of intraocular pressure, and that was reduced to 39 eyes who were controlled without the need of medication or a new procedure after 2 years' control.

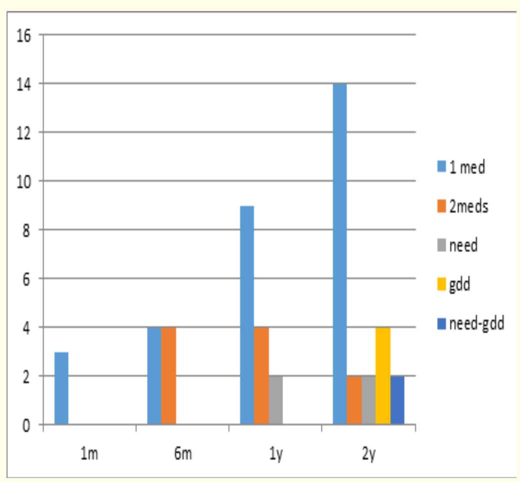
Success and Failure of Mpds After 1 Year of Surgery	
	Patients
Success	43
Failure	15
MPDS: Microperforating deep sclerotomy	

Figure 10: *Success rate after 1 year follow up.*

Success and Failure of Mpds After 2 Years of Surgery	
	Patients
Success	39
Failure	19
MPDS: Microperforating deep sclerotomy	

Figure 11: *Success rate after 2 years follow up.*

Out of 19 cases which did not control, 8 required a new procedure 4 needlings and 4 implant of a drainage device (Ahmed Valve, new world medical). The rest of the patients regulated their tonometry figures with 1 drug in cases and with 2 drugs in 3 patients. No cases of endophthalmitis were reported (Figure 12).



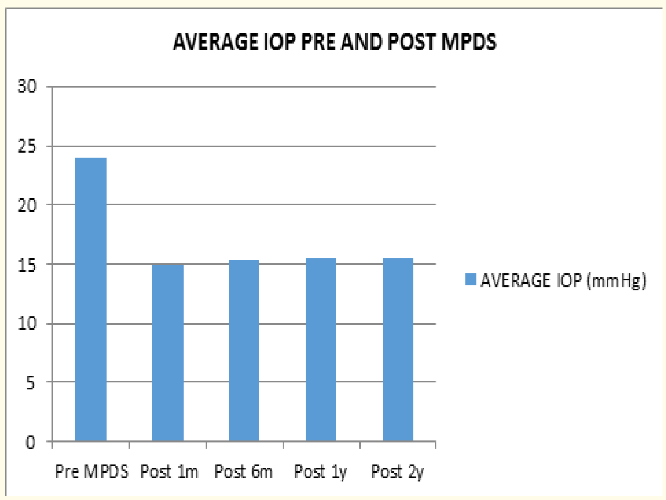
Need of Medication or Second Procedure After MPDS						
AFTER	1med	2meds	Need	Gdd	Need-Gdd	TOTAL
1m	3	0	0	0	0	3
6m	4	4	0	0	0	8
1y	9	4	2	0	0	15
2y	14	2	2	4	2	24
MPDS: Microperforating deep sclerotomy; 1med: 1 glaucoma eye drop; 2meds: 2 glaucoma eye drops; Need: needling; Gdd: Glaucoma drainage device.						

Figure 12: *Other procedure needed in failed MPDS.*

Conclusions

The modification from the deep non penetrating Sclerotomy into a Microperforating surgery, making goniopunctures on the trabecular descemetic membrane, not only allows reducing the risk of complications of perforation with conversion into trabeculectomy, or not getting a membrane which keeps an appropriate filtration, during the learning curve. These technical difficulties are usually the main cause many people choose other procedures for glaucoma surgery, with more risks of complications or lower hypotension effect.

It shows appropriate IOP control without the need of repeating treatment in 39 eyes, and 47 eyes with a mono-drug therapy after two years of the follow-up, which shows that it is a technique with a significant success rate on the medium term, showing control IOP under 16 mm hg in promedy after 2 years, but with an extremely high safety rate, since no considerable complications were reported in any of the cases (Figure 13).



AVERAGE IOP PRE AND POST MPDS					
	Pre MPDS	Post 1m	Post 6m	Post 1y	Post 2y
AVERAGE IOP (mmHg)	24,07	14,98	15,32	15,52	15,45
MPDS: Microperforating deep sclerotomy; IOP: intraocular pressure; Post 1m: 1 month after surgery; Post 6m: 6 months after surgery; Post 1y: 1 year after surgery; Post 2y: 2 years after surgery					

Figure 13: *Intraocular Pressure control after Microperforating Deep Sclerectomy in 2 years follow up.*

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