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Minimally Invasive Strabismus Surgery for Horizontal Concomitant Strabismus

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ABSTRACT

Background: strabismus is a condition in which the eyes are not properly aligned with each other. It typically involves a lack of coordination between the extraocular muscles. Strabismus can present as manifest (heterotropia), apparent, latent (heterophoria) varieties.

Objective: the present study aimed to compare the minimally invasive strabismus surgery (MISS) as an alternative to limbal approach for horizontal concomitant strabismus.

Patients and Methods: the study included 50 patients of different ages and sexes, presented with transverse strabismus, for elective surgical correction. They allocated into two equal groups; the first group included 25 cases who were managed by MISS (patients group); the second group included the other 25 cases who were managed by limbal approach (control group).

Results: the results were evaluated at one week, three week and six week as regards to visibility of surgical wound, post-operative conjuntival redness, patient discomfort, surgical opening related complications and post-operative correction at first week, third and six months. Few complications were seen with the MISS technique and they were mostly related to the surgery not to the technique itself.

Conclusion: the minimally invasive strabismus surgery has the same effect as limbal approach as obvious by the similar success rate. Its stability is as good as the stability of limbal incision. It has the advantages of sparing perilimbal episcleral vessles which make it a good choice instead of limbal approach whenever there is fear of anterior segment ischemia.

Keywords: Extraocular muscle, Minimally invasive strabismus surgery, Exotropia.

INTRODUCTION

Minimally invasive surgery has been one of the most important revolutions in surgical techniques since the early 1900s [(1)].

In ophthalmology, many minimally invasive procedures have been developed over the past decades for examples, phacoemulsification for cataracts and 23-gague sutureless vitrectomy [(2)].

For rectus muscles, the majority of strabismus surgeons use Harms' limbal approach, which has been popularized by von Noorden [(3)]. This is a limbal opening over a quadrant, allowing full visualization of the operated muscle. Parks [(4)] in 1986 introduced and popularized a fornix-based conjunctival incision for rectus muscle access, which remains covered by the lids after sugery.

In recuts muscle strabismus surgery, several varieties to reduce the conjunctival incision size have been published after Harms published his widely used limbal approach [(5)].

Smaller conjunctival openings, especially if placed away from the limbus, will induce less tissue disruption and less postoperative discomfort. Probably, they also reduce the risk for an anterior segment ischemia [(6)].

A nice alternative to a limbal opening, which can be used in patients with elastic conjunctiva as in children, is Park's fornix opening [(7)].

Another alternative for rectus muscle exposure, which further reduces anatomical disruption and can be used also in patients with inelastic conjunctiva, uses two keyhole openings placed near to the muscle insertion [(8)].

Gobin [(9)] in 1994 was the first to describe the principle of access for rectus muscles through two small radial openings one along the superior and the other along the inferior muscle margin .

A new access for horizontal rectus muscle recession and plication has been used. Muscle exposure was performed through only two small radial cuts, one along the superior and the other along the inferior margin of the horizontal muscles, allowing to perform minimally invasive strabismus surgery (MISS), as the opening and tissue dissection are minimized [(10)].

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The technique established in these horizontal recuts muscle operations may be applied to all types of strabismus surgery. One exception, however, is reoperation on an already maximally recessed rectus muscle with very restricted ocular motility e.g. in a case of severe thyroid orbitopathy [(11)].

The concept of MISS consists of the following principles: Placement of all conjunctival cuts as far away from the limbus as possible, avoidance of conjunctival opening was not necessary to perform the surgical steps, reduction of conjunctival opening size by using multiple keyhole openings instead of one large access, placement of keyhole cuts in a way to permit joining them if increased visibility is needed, performance of all feasible surgical steps through tunnels, and minimization of perimuscular tissue disruption [(12)].

Post-operatively, MISS openings will remain covered by the eyelids and will minimize visibility of surgical wound, patient discomfort and limbus opening related complications, e.g. corneal complications. Long-term benefits include avoidance of an increase of redness of the conjunctiva and a decreased scarring of the perimuscular tissue, which will facilitate reoperations [(13)].

There is increasing evidence suggesting that the disruption of the peri limbal episcleral vessels – which occurs with a limbal incision may predispose to anterior segment ischaemia, MISS will preserve the majority of peri limbal episcleral vessels [(12)].

Patients with reduced elasticity of the conjunctival tissue require larger cuts in order to avoid conjunctival tearing while working with instrument. Since the cuts are far away from the limbus, usually this will not induce a foreign body sensation [(14)].

AIM OF THE WORK

To compare MISS technique for horizontal concomitant strabismus with the usual limbal approach as regard: Visibility of surgical wound, Patient discomfort, Surgical opening related complications, Post-operative conjunctival redness, Scarring of peri muscular tissue, Anterior segment ischaemia.

PATIENTS AND METHODS

Patients: This study included 50 patients presented with various patterns of horizontal deviation presented in Al-Azhar University Hospitals from June 2016 to August 2017. According to surgical maneuver, eyes were classified into two equal groups: Group 1 (control group): included 25 eyes with limbal approach. Group 2 (patients group): included 25 eyes with minimally invasive strabismus surgery.

Inclusion criteria: Patients with horizontal deviation with variable angle of deviation at variable age groups, absence of other ocular diseases that could affect the motility of the muscle, and parents have the ability to understand and sign consent form.

Exclusion criteria: Ocular inflammatory conditions, recurrent strabismus, patients with known hypersensitivity to anastheia, restrictive strabismus, paralytic strabismus, dense corneal opacity, blind patient and increased bleeding time.

Methods:

All patients were subjected to the following preoperative evaluation: Full and detailed history: which included the following:

Personal history: Name, age, gender, address and telephone number, and complaint.

Present history: Given by the patient or by person from family of the child. Age of onset, frequency of the ocular misalignment, nature of squint, is it unilateral or alternating? and other eye problems.

Birth and developmental history: Prenatal history: Diseases or drugs used during pregnancy. Natal history: Complications during labor. Postnatal history: Child weight at birth and maturity of the baby and incubated or not.

Family history: of squint, consanguinity, amblyopia or hereditary diseases.

Past history: of ocular injuries, fever, surgery and treatments (including eye glasses and, or amblyopia therapy).

Measurement of angle of deviation:

Hirschberg test: using reflection produced by penlight on both corneas.

Krimsky's method: Corneal reflection is produced in the two eyes by a penlight, which is fixated by the patient's better eye. Prisms are then placed in front of the fixating eye to center the corneal reflection in the deviated eye.

Cover test: The cover uncover test to differentiate phoria from tropia. The prism and cover test: by using the prism to measure the angle of deviation after dissociation was made by alternate cover test.

The patients were divided into two groups: Group (1): included 25 patients treated

with limbal approach Esotropia or Exotropia, Recession or Resection.

Surgical technique for traditional, limbal approach: Limbal periotomy with two radial relaxing incisions are performed over the muscle .With blunt Wescott scissors the epi scleral tissue is separated from the muscle sheath and sclera. When the borders of the muscle have been identified, the muscle is hooked. Then a meticulous dissection of the check ligaments and intramuscular membrane is performed.

Continue for recession: Vicryl sutures (6-0) are placed at the upper and lower poles of the muscle insertion, locked and secured. The muscle is cut at the insertion and the muscle is carefully resutured at sclera at the planned position after measurging the distance with caliber.

Continue for resection or plication: Vicryl sutures (6-0) are passed at the upper and lower pole of the muscle at the planned position for resection or plication, locked and secured. The muscle is divided in front of the suture level for resection or folded over for plication. The surgical procedure is finished by readapting the conjunctiva, applying four to six sutures with Vicryl 8-0. At the end of surgery, combination of antibiotic and steroid ointment was applied. No eye patch was used.

Group (2): included 25 patients treated with MISS either Esotropia or Exotropia, Recession or Rescection.

Surgical technique for MISS: A limbal traction suture (e.g., 6-0 silk) is passed. Two radial keyhole para insertional cuts are made parallel to the upper and lower margin of the muscle. The length should be 1 mm shorter than the planned magnitude if the rectus muscle recession or plication less than 5 mm and 2 mm if recession or plication more than 5 mm. Small sub-Tenon tunnels joining the two incisions are made with Westcott scissors over the surface of the muscle, avoiding the muscular vessels. The muscle is hooked and cauterization of the prominent blood vessels at the insertion underneath the conjunctiva is performed.

Continue for recession: Vicryl sutures (6-0) are placed at the upper and lower poles of the muscle insertion, locked and secured. The muscle is cut at the insertion under the conjunctiva. The muscle is carefully re sutured at sclera at the planned position.

Continue for resection or plication: Vicryl sutures (6-0) are passed at the upper and lower pole of the muscle at the planned position for resection or plication, locked and secured. The sutures are placed through the muscle insertion ensuring an adequate anchoring scleral bite. The muscle is divided in front of the suture level for resection or folded over for plication. The surgical procedure is finished by readapting the conjunctiva, applying single suture with Vicryl 8-0. At the end of surgery, combination of antibiotic and steroid ointment was applied. No eye patch was used.

Follow up: The patients were examined at one week, three week and six week and post-operative correction at first week, third and six months.

Statistical Analysis

Data were collected, revised, coded and entered to the Statistical Package for Social Science (IBM SPSS) version 20. Qualitative data were presented as number and percentages while quantitative data were presented as mean, standard deviations and ranges.

Chi-square test or **Fisher exact test** was used to compare between qualitative data. The comparison between two groups regarding quantitative data with parametric distribution were done by using **Independent t-test** while more than two group regarding quantitative data with parametric distribution were done by using **One Way Analysis of Variance (ANOVA).**

The confidence interval was set to 95% and the margin of error accepted was set to 5%. So, the p-value was considered significant as the following:

$P > 0.05$: Non significant

$P < 0.05$: Significant

$P < 0.01$: Highly significant.

RESULTS

Table (1): Comparison between MISS group and control groups as regard Visibility of surgical wound.

Visibility of surgical wound		MISS group		Control group		Test value*	P-value	Sig.
		No.	%	No.	%			
1st week	Negative	0	0.0%	0	0.0%	2.400	0.301	NS
	+	3	12.0%	2	8.0%			
	++	17	68.0%	13	52.0%			
	+++	5	20.0%	10	40.0%			
3rd week	Negative	6	24.0%	0	0.0%	10.410	0.015	S
	+	15	60.0%	13	52.0%			
	++	4	16.0%	11	44.0%			
	+++	0	0.0%	1	4.0%			
Six week	Negative	18	72.0%	12	48.0%	3.000	0.083	NS
	+	7	28.0%	13	52.0%			
	++	0	0.0%	0	0.0%			
	+++	0	0.0%	0	0.0%			

•: Independent t-test; *: Chi-square test; NS: Non significant; S: Significant

Regarding Visibility of surgical wound no significant difference at first and six week but significant difference at third week.

Table (2): Comparison between MISS group and control groups as regard post-operative conjunctival redness.

Post operative conjunctival redness		MISS group		Control group		Test value*	P-value	Sig.
		No.	%	No.	%			
1st week	Negative	0	0.0%	0	0.0%	0.148	0.929	NS
	+	5	20.0%	4	16.0%			
	++	13	52.0%	14	56.0%			
	+++	7	28.0%	7	28.0%			
3rd week	Negative	13	52.0%	8	32.0%	3.281	0.194	NS
	+	6	24.0%	12	48.0%			
	++	6	24.0%	5	20.0%			
	+++	0	0.0%	0	0.0%			
Six week	Negative	25	100.0%	23	92.0%	2.083	0.353	NS
	+	0	0.0%	1	4.0%			
	++	0	0.0%	1	4.0%			
	+++	0	0.0%	0	0.0%			

•: Independent t-test; *: Chi-square test

NS: Non significant

Regarding post-operative conjunctival Redness no significant difference at first, third and six week.

Table (3): Comparison between MISS group and control groups as regard Patient discomfort.

Patient discomfort		MISS group		Control group		Test value*	P-value	Sig.
		No.	%	No.	%			
1st week	Negative	0	0.0%	0	0.0%	1.548	0.461	NS
	+	10	40.0%	8	32.0%			
	++	13	52.0%	12	48.0%			
	+++	2	8.0%	5	20.0%			
3rd week	Negative	19	76.0%	14	56.0%	3.515	0.172	NS
	+	5	20.0%	6	24.0%			
	++	1	4.0%	5	20.0%			
	+++	0	0.0%	0	0.0%			
Six week	Negative	21	84.0%	22	88.0%	0.166	0.684	NS
	+	4	16.0%	3	12.0%			
	++	0	0.0%	0	0.0%			
	+++	0	0.0%	0	0.0%			

•: Independent t-test; *: Chi-square test

NS: Non significant

Regarding Patient discomfort there was no significant difference at first, third and six week.

Table (4): Comparison between MISS group and control groups as regards early postoperative surgical complications.

	MISS group	Control group	Test value*	P-value	Sig.

Surgical opening related complications	No.	%	No.	%			
No	20	80.0%	19	76.0%	0.117	0.732	NS
Lid swelling	2	8.0%	3	12.0%	0.222	0.637	NS
Allergic reaction	1	4.0%	0	0.0%	1.02	0.312	NS
Stitch granuloma	1	4.0%	1	4.0%	0.000	1.000	NS
Come ulcer	1	4.0%	0	0.0%	1.02	0.312	NS
Tenon prolapse	0	0.0%	1	4.0%	1.02	0.312	NS
Dellen for mation	0	0.0%	1	4.0%	1.02	0.312	NS

•: Independent t-test; *: Chi-square test
NS: Non significant

As regard surgical complications were reported in 20 % of cases MISS and 26 % of cases limbal apprpach, it was in the form of lid swelling in 5 cases (2 in MISS and 3 in limbal approach), allergic reaction in 1 cases of MISS, Stitch granuloma 2 cases one in each group, corneal ulcer one case of MISS, tenon prolapse one case of limbal approach, Dellen formation in one case of limbal approach. With there was no significant difference between MISS group and control groups.

Table (5): Muscle alignment among the studied patients with various pattern of horizontal deviation at one week and one month.

Correction post-operative	MISS group		Control group		Test value*	P-value	Sig.
	No.	%	No.	%			
Ortho	20	80.0%	22	88.0%	0.595	0.440	NS
Ortho with glasses	1	4.0%	1	4.0%	0.000	1.000	NS
Residual ET	1	4.0%	1	4.0%	0.000	1.000	NS
Residual ET with glasses	1	4.0%	0	0.0%	1.020	0.313	NS
Residual XT	2	8.0%	1	4.0%	0.355	0.551	NS
Recurrent XT	0	0.0%	0	0.0%	0.000	1.000	NS
Consecutive ET	0	0.0%	0	0.0%	0.000	1.000	NS

•: Independent t-test; *: Chi-square test
NS: Non significant

Success rates:

Success was considered to be achieved a postoperative alignmenet within 10 PD, and failure was considered as postoperative angles greater that 10 PD.

In MISS group, the success rate was 20 cases at 1 week of follow up. In limbal approach group, success rate was 22 cases at 1 week of follow up. The difference between both groups was statistically insignificant.

Table (6): Muscle alignment among the studied patients with various pattern of horizontal deviation at three months.

Follow up at 3 months	MISS group		Control group		Test value*	P-value	Sig.
	No.	%	No.	%			
Ortho	19	76.0%	21	84.0%	0.500	0.480	NS
Ortho with glasses	2	8.0%	1	4.0%	0.355	0.551	NS
Residual ET	1	4.0%	1	4.0%	0.000	1.000	NS
Residual ET with glasses	0	0.0%	0	0.0%	0.000	1.000	NS
Residual XT	2	8.0%	1	4.0%	0.355	0.551	NS
Recurrent XT	1	4.0%	0	0.0%	1.020	0.313	NS
Consecutive ET	0	0.0%	1	4.0%	1.020	0.313	NS

•: Independent t-test; *: Chi-square test
NS: Non significant

The success and failure rates were again compared at 3 months follow up and the results were as follow; in the MISS group, 19 patients were successfully aligned. In the limbal approach group, the success rate was 21 cases, the difference between both groups was statistically insignificant.

Table (7): Muslce alignmnet among the studied patients with various pattern of horizontal deviation at six months.

Follow up at 6 months	MISS group	Control group	Test value*	P-value	Sig.

	No.	%	No.	%			
Ortho	17	68.0%	20	80.0%	0.936	0.333	NS
Ortho with glasses	2	8.0%	1	4.0%	0.355	0.551	NS
Residual ET	1	4.0%	1	4.0%	0.000	1.000	NS
Residual ET with glasses	0	0.0%	0	0.0%	0.000	1.000	NS
Residual XT	2	8.0%	1	4.0%	0.355	0.551	NS
Recurrent XT	2	8.0%	1	4.0%	0.355	0.551	NS
Consecutive ET	1	4.0%	1	4.0%	0.000	1.000	NS

•: Independent t-test; *: Chi-square test
NS: Non significant

The Success and failure rates were again compared at 6 months follow up and the results were as follow; in MISS group, 17 patients were successfully aligned. In the limbal approach group 20 patients were successfully aligned, there was no statistically significant difference between the two groups.

DISCUSSION

The aim of this study was to evaluate and compare between minimally invasive strabismus surgery and the standard limbal approach for horizontal concomitant strabismus as regards to visibility of surgical wound, post-operative conjuntival redness, patient discomfort, surgical opening related complications at one week, three week and six week and post-operative correction at first week, third and six months.

In this study, a postoperative deviation within 10 PD was considered a successful result.

It was found the success rate in this study was 21 (84%) cases in MISS at 1 week postoperatively while the success rate in limbal approach at the same time was 23 (90%) cases. Three months postoperatively, the success rate in MISS was 21 (84%) cases but the success rate in the limbal approach was 22 (88%) cases. By six months postoperatively, the success rate in MISS was 19 (76%) cases and 21 (84%) cases in the limbal approach, the difference between the two groups was not statistically significant.

This was very similar to another study done by **Ioannis *et al.*** [15], who stated that MISS has equally successful outcomes compared to conventional strabismus surgery [15], also similar to another study done by **Mojon** [8] who stated that in a 6-month prospective study comparing patients operated on with MISS (n = 20) versus a matched, non-concurrent, retrospective comparison group (n = 20), reported that no significant difference was detected for final ocular alignment, binocular single vision, visual acuity, refractive change, or complications.

According to conjunctival incision in MISS four cases needed extended incision and we convert them to limbal incision, also haemorrage was recorded in one case and we converted it to limbal incision, these cases not included in this study these results are in agreement with **Merino *et al.*** [16] who stated that in cases with hard to control bleeding this may necessitate keyhole enlargement that will allow adequate exposure for cauterization.

Disruption of the anterior ciliary arteries did not occur in any of our cases, although this complication was encountered by Wright and Lanier in their study on animal models while dissecting the check ligaments of the inferior rectus muscle [17].

The results regarding visibility of surgical wound at first week showed that there was no statistical significant difference between MISS and limbal approach but number of cases as regard visibility of surgical wound is higher in limbal approach than MISS. At third week there was statistical significant difference between MISS and limbal approach. At six months there was no statistical significant difference between two groups but number of cases was less in MISS than limbal approach, this conicide with Pellanda and Mojon [13] who stated that the real value of MISS lies in the long-term benefit of reduced fibrosis that will facilitate future reoperations.

This also agrees with **Mojon** who stated that the advantages of MISS included decrease post-operative visibility of surgical wound [11].

The result as regard post-operative conjunctival redness at first week, third week and six months showed that no statistical significant difference between MISS and limbal approach but number of cases as regard conjuntival redness is less in MISS than limbal approach all time. This study agrees with the study done by **Mojon** in the first six months of the follow up period who stated that the

advantages of MISS include reduced redness of the conjunctiva [11].

As regard patient discomfort at first week, third week and six months there was no statistical significant difference between MISS and limbal approach but number of cases as regard patient discomfort is less in MISS than limbal approach at all times. This study agree with the study done by Mojon during follow up period who stated that this method involves performing strabismus surgery through keyhole openings to decrease tissue trauma, minimize postoperative complications and patient discomfort, and improve surgical outcomes [8].

In the present work, at the first postoperative week no complications were reported in 80% of cases in MISS and 76 % in limbal approach. Complications that were reported in the form of lid swelling in 2 cases (8.0 %) in MISS and three cases (12.0 %) in limbal approach. Allergic reaction one case (4.0%) in MISS. Stitch granuloma occure in one case in each group (4.0%). Corneal ulcer occurs in one case in MISS (4.0%). Dellen formation and tenon prolapse one case in limbal approach (8.0%), with no significant difference between patients group and control group. From this study we noticed that no complication specific to each group but some complication increase with each technique. For example corneal ulcer and scleral perforation increase with MISS but tenon prolapse, dellen formation and lid swelling increase with limbal approach.

Prolapse of Tenon's capsule occurred in one patient in limal group, but it was so small that it needed no treatment and it shrink back to its original site under the conjunctiva. This was supported by Helveston who stated that the prolapsed Tenon's capsule would shrink back into the conjunctival wound unless it is excessive then it should be excised and the conjunctiva overlying it sutured [18].

Anterior segment ischaemia was not detected in any case done either by MISS or limbal approach. This dose not agree with Kushner BJ who said Preservation of perilimbal episcleral vessels as perilimbal blood vessels remain intact following MISS, the risk of postoperative anterior segment ischemia is greatly reduced compared to the conventional surgical techniques that require dissection of the limbal conjunctiva [6].

As regard post operative scarring of peri muscular tissue we can not distinguish between two groups because no surgical intervention was done again in both study groups. Two patients with residual exotropia accepted the result; one patient with residual esotropia has no detected angel under glasses and one patient with residual esotropia refuse reoperation.

The results regarding the amount of correction of the strabismic angles were nearly the same in both groups denoting that MISS had the same effects as limbal approach. Number of ortho cases in MISS was 21(84%) case post operatively which remained as it after three months and the number of ortho cases decreased to 19 (76%) case after six months in which one case has recurrent exotropia due to amplyopia and another case has consecutive esotropia. In comparison with the number of ortho cases in limbal approach 23 (92%) cases post operatively which decreased to 22 (88%) cases after three months and decrease again to 21 (84%) cases after six months in which one case has consecutive esotropia and another case has recurrent exotropia due to amplyopia respectively with no statistical significant difference between two groups.

In the present study according to time of surgery MISS time ranged from 20-60 minute with amean of 43.33±10.07 minutes, while limbal approach time ranged from 15-40 minute with amean of 30.00±5.59 minutes and there was highly statistically significant decrease of limbal approach time in comparison to MISS time, and this agree with Merino et al., who said Surgical time is longer, at least for the surgeon who is unfamiliar with MISS [19].

At the end we must reminde that MISS technique losses some advantages than limbal approach: Conjuntival recession in esotropia which act as augmentation of recession. Large angel of esotropia or exotropia needs larger incision which is similar to limbal approach. Recurrent strabismus done by limbal approach, fornix incision technique and hang back technique is not suitable to be done again by MISS. Some previous surgeries hinder MISS technique as buckle in retinal detatchment. Not any age suitable for MISS, the recommended age between 14 and 40 years, small age have excssive tenon and old age have inelastic conjunctiva. In recession if sagging occur it may not be noticed.

Fornix incision technique has nearly the same advantages of MISS as regard patient discomfort, visibility of surgical wound and post operative conjuntival redness so fornix incision considered minimally invasive

surgery, this coincide with ***Merino et al.*** who stated that this approach results in minimal postoperative edema or discomfort, and the incision is usually hidden from view and MISS doesn't appear to offer much advantage for surgeons already using a fornix-based approach [(16)].

This also agree with paper done by ***Granet et al.*** who stated that we think our fornix surgery is already minimally invasive, which avoids disruption of the episcleral perilimbal vessels and we make very small incisions, hook muscles through these tiny incisions, keep bleeding to a minimum surgical time is longer, at least for the surgeon who is unfamiliar with MISS [(20)].

Muscle disinsertion should be done with careful attention to the technique, if the cut is placed too close to the sclera, a permanently visible bluish line along the muscle insertion may ensue. If, on the other hand, the cut is placed too far from the sclera, the remaining tendon may form a visible elevation of the conjunctiva [(16)].

We want to say that incision is an important steb in strabismus surgeries and minimal invasive technique has gained popularity in many fields of ophthalmology like phacoemusification and other procedures that enable to early rehabilitation and less postoperative discomfort and equally successful outcomes. So, choice type of incision and surgery is an important. MISS is a good technique suitable for patient age between 10 -40 years, not to larg angel esotropia or exotropia to avoid larg incision, primary not for recurrent strabismus especially if surgery done by another technique limbal or fornix and it has learning curve more than other procedures so who want to learn MISS must come to watch in the operating theater and assist one day [(11)].

Although the short-term advantage of faster rehabilitation and more satisfactory cosmesis can be important for some patients, the real value of MISS lies in the long-term benefit of reduced fibrosis that will facilitate future reoperations should these be needed. The decreased likelihood of anterior chamber ischemia owing to the preservation of limbal blood vasculature is obviously an added potential benefit of MISS [(13)].

Fornix-based procedures; this approach results in minimal postoperative edema or discomfort, and the incision is usually hidden from view so considered minimally invasive procedure but has disadvantage like MISS it is difficult to perform in children because of their prominent Tenon's capsule, in cases with significant preexisting scarring, and in older patients with inelastic conjunctiva [(16)].

Limbal approach; this technique permitted full visualization of the muscle undergoing operation and avoided excessive scarring and bleeding over the muscle tendon. Some common postoperative complications included discomfort, interpalpebral conjunctival redness, corneal dellen, and Tenon's capsule prolapse [(10)].

Undoubtedly MISS is currently the preferred approach of only a minority of surgeons worldwide and thus traditional techniques utilizing limbal or fornix conjunctival incisions remain most popular in many parts of the world [(21)].

CONCLUSION

From the results of this study, it can be concluded that minimally invasive strabismus surgery technique is an alternative technique to limbal or fornix technique that can be used on horizontal muscles especially when Preservation of perilimbal episcleral and early rehabilitation is needed.

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