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Efficacy of using Laser Assisted Adjustable Suture in the Management of Residual Angle Exotropia

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***Abstract*---**To assess the efficacy of using argon laser suture lysis of adjustable sutures used in strabismus surgery in the management of residual exotropia following surgery for intermittent exotropia. A prospective interventional study was conducted on 30 patients with basic type of intermittent exotropia. Sixty eyes were included from November 2018 to December 2019. All patients were operated on with Ripcord adjustable sutures under general anesthesia. On the first day postoperatively, if alignment was satisfactory (within 10 DP), the ripcord suture was kept in place. If there was residual exotropia more than 10 DP, suture can be cut in less than five applications by argon laser lysis and the muscle retracts posteriorly, producing additional recession of the muscle. Thirty patients were enrolled with ages ranging from 15 to 47 years and an average of 25.93±10.5 years. The mean preoperative angle was 44.3±8.8 DP, ranging from 25 to 60 DP. There was no postoperative significant residual angle in 12 patients

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(40%) immediately after the operation and throughout the follow-up period of 3 months but there were 18 patients (60%) with postoperative significant residual angle and argon laser suture lysis was done for them, then they were followed-up for 3 months. The overall success rate was 96.7%. Use of argon laser in adjustable sutures after strabismus surgery for patients with residual exotropia had a success rate of 94.4% and the overall success rate was 96.7%. The technique can help achieve successful alignment in patients with residual angle.

Keywords---adjustable suture, argon laser, exotropia, strabismus.

Introduction

Intermittent exotropia is a form of exodeviation that is governed by fusional mechanisms. An exophoria process is often followed by the exotropia, and the deviation is most evident when children are exhausted, ill, or inattentive, or after a prolonged close reading activity. Adult patients may experience exodeviation following the consumption of alcoholic beverages or the use of sedatives (Yang et al., 2008).

Patients with late exotropia after the ages of 6–7 years may develop diplopia because of loss of visual pliability. The bright sunlight blinks the retina so that it disrupts fusion, which makes the deviation manifest and closes the eye. Monocular sunlight eye closure is a mechanism for photophobia reduction that is not connected with diplopia avoidance (Wang & Chryssanthou, 1988; Wiggins & von Noorden, 1990).

Management of exotropia is either conservative or surgical correction when the conservative management is failed. Surgery is thought to be an effective method for the treatment of intermittent exotropia (Figueira & Hing, 2006). The targets of the operation in management of intermittent exotropia are restoration of alignment and preservation of binocular function (Buck et al., 2007). The defintive operative management of intermittent exotropia is done by lateral rectus recession and/or medial rectus muscle resection (Hassan et al., 2018).

In some studies, the reported success rate in all types of intermittent exotropia is about 60–70% (Ing et al., 1999; Saleem et al., 2013; Scott et al., 1981; Souza-Dias, 1993). Patients after surgical management of intermittent exotropia may still suffer due to occurrence of under correction especially after bilateral recession of lateral rectus, overcorrection and esotropia (Kelkar et al., 2015).

To avoid such complications, the adjustable sutures can be used as Tripathi and his colleagues described the role of adjustable suture technique in securing the extra ocular muscle through a temporary or sliding knot aiming to reduce the need to reoperation by assessment of the alignment in the early period after the surgery before reattachment of the rectus muscle to sclera (Tripathi et al., 2003). Even after the adjustable sutures in management of exotropia, patients may still have many side effects as asymmetrical length of sutures after the retying,

unquantifiable amount of adjustment, and failure to end the procedure as soon as possible (Tsai, 2017), slipping of the muscle, the requirement for more manipulations during adjustment to locate the suture, and Increased suture granulomas incidence (Nihalani et al., 2009). These drawbacks of adjustable sutures can be manipulated by laser suture lysis that enables the surgeon to apply tight sutures and recover them after the operation when needed 18-19 (Hoskins & Migliazzo, 1989). This study was conducted to assess the efficacy of argon laser suture lysis of adjustable sutures used in strabismus surgery in the management of residual exotropia following surgery for intermittent exotropia.

Methods

Study type, site, and duration

A prospective interventional study was conducted on 30 patients in Beni-Suef University Hospital with basic type of intermittent exotropia. Sixty eyes were included fulfilling the inclusion criteria during the period from November 2018 to December 2019.

Inclusion and exclusion criteria

Patients with basic type of intermittent exotropia, aged above 15 years, and didn't undergo any strabismus surgery while patients with any of the following criteria were excluded, patients with other type of exotropia, with history of any previous strabismus or any ocular surgery, and with any systemic manifestations.
Procedure:

Preoperative evaluation

Each patient underwent detailed preoperative ophthalmological examination including visual acuity, full cycloplegic refraction, full ocular examination using slit lamp and indirect ophthalmoscopy. Routine alternating cover prism examination can be challenging in a patient with intermittent exotropia due to the variable angle of deviation so, repeated alternate cover examination can be used to prevent tonic fusional convergence. If there is substantial angle deviation or a significant distance/near difference after repeated alternative cover examination, a patch test is recommended. The patch test is not needed for patients who have clear dimensions and no major distance-near difference.

Operative procedure

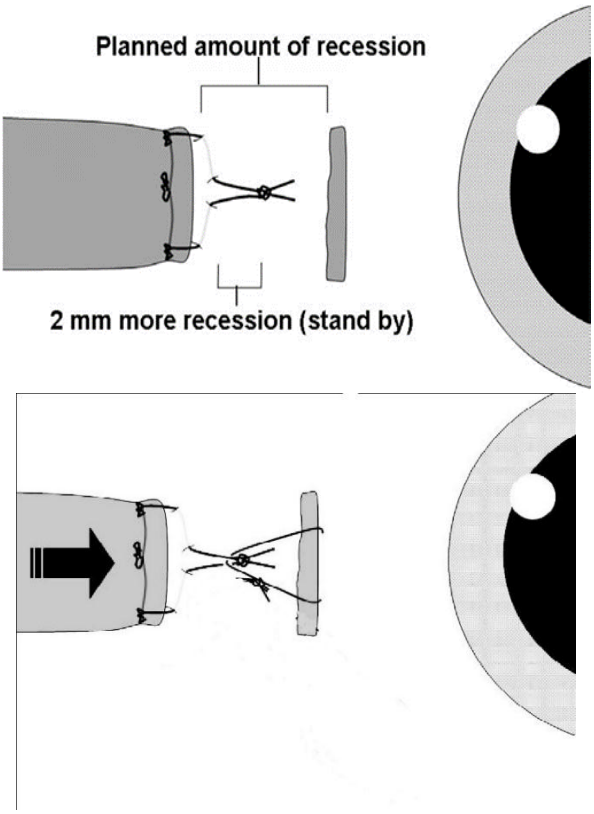
All patients were operated on with Ripcord adjustable sutures under general anesthesia. Ripcord sutures were positioned in such a way that the muscle suture could clearly be distinguished from the muscle suture, preventing the incorrect suture from being cut after surgery. Limbal incision was used to conduct recess in all lateral recti muscles; 20 muscles were recessed using direct scleral fixation procedure, and 40 muscles were recessed using the following cuttable ripcord suture technique.

Muscle recession

After isolation of the lateral rectus muscle, a double-armed 6/0 polyglactin was

used to secure the muscle and locked 1 mm from the insertion (Vicryl; Ethicon Inc, Pasadena, CA). The muscle was disinserted. The caliper was adjusted to the desired degree of recession and was used to mark the scleral entry points. The entry marks were one muscle width apart, and the sutures were threaded into 3-mm scleral tunnels to emerge close together in a parallel pattern to the insertion plane. Again the caliper was adjusted to 2 mm, as well as the suture arms were pulled up, weighted for the 2-mm caliper width, tied together, and cut in the same way as in the hang-back procedure. This resulted in the muscle sagging 2 mm posterior to the scleral entry point.

The adjustable Suture

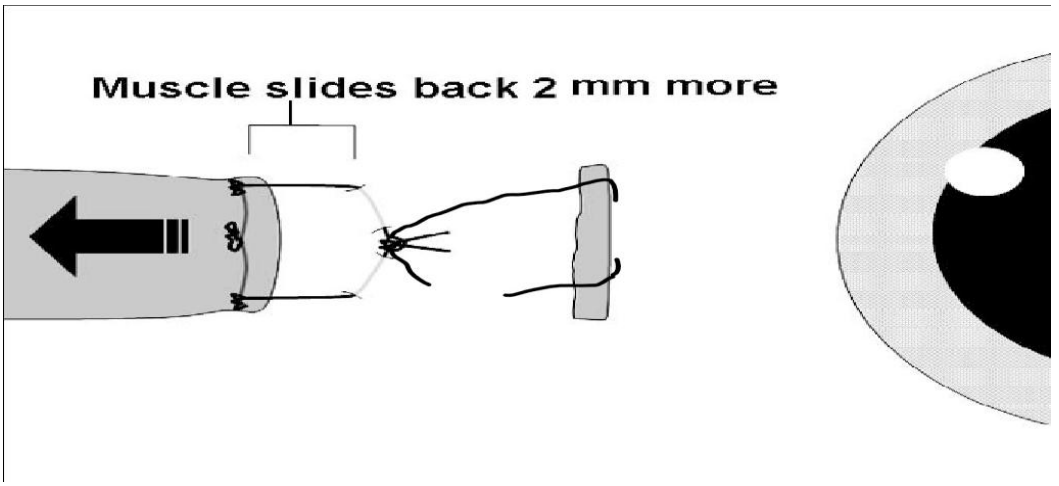


Another single-armed, spatulated needle of 10/0 nylon suture was passed under the muscle suture knot then through the sclera anterior and parallel to the insertion. The end of this suture is tied in a tightened square knot with two tying forceps. Doing this the muscle moved anteriorly to the scleral entry. After wrapping the nylon suture, its ends were cut and hidden deep the conjunctiva after shaving the underlying tenon to allow easy observation and future laser cutting if necessary. The limbal conjunctival wound was closed.

During planning of recession, a postoperative under correction was aimed as this technique is not beneficial in postoperative overcorrection. We used a standard chart to determine the number of millimeters of recession needed a specific target

angle.

Postoperative



On the first day postoperatively, if alignment was satisfactory (within 10 DP), the nylon suture was kept. If there was residual exotropia more than 10 DP, lidocaine hydrochloride 2% jelly (Xylocaine 2% jelly; Astra, Westborough, MA) was instilled to the eye for few minutes. The lid then was open, and a Hoskin lens was applied. Gentle pressure with the Hoskin lens helps to blanche the conjunctival vessels and displace the fluids from the conjunctiva overlying the suture and thus enabling more visualization of the scleral sutures needed to be cut. In a cooperative patient and with good visibility the nylon suture was cut in less than five applications of argon laser allowing the muscle to move backward 2 millimeters more producing additional recession of the muscle. Following suture lysis, the patient was examined again on the slit lamp after a few minutes and was asked to look side to side repeatedly to facilitate suture retraction in some cases.

Postoperative follow-up

Postoperative examinations were performed on the first-day postoperatively, at months 1, 3. It included refraction, measurement of the best-corrected visual acuity (BCVA), slit-lamp examination, fundus examination and ocular alignment using alternate prism cover test.

Statistical analysis

At the end of this study, data were statistically analyzed and presented in terms of mean ± standard deviation (± SD) for scale variables, number and percentages when for categorical variables. All statistical calculations were made using computer programs IBM® SPSS® Statistics Version 25. P-values less than 0.05 were considered statistically significant (SPSS Inc., 2013).

Mann-Whitney U test was used to test the difference between two groups egarding a not normally distributed variable (comparison between patients with non-significant postoperative residual angle & versus patients with postoperative significant residual angle regarding their age, pre-operative angle and comparison between patients needed bilateral suture laser cutting and patients needed unilateral cutting of the ripcord suture regarding the postoperative adjustment angle (DP)) , Wilcoxon signed rank test was used to compare each 2 measures of follow up of data regarding a not normally distributed variable in addition to repeated measure ANOVA test was used to follow-up the change in angle of deviation till the end of follow-up period of 3 months (one day, 1st month and 3rd month). While Chi-Squared (Fisher exact) test was used to test the associations between categorical variables.

Ethical consideration

The study was statistically approved by the Research Ethics Committee of Faculty of Medicine, Beni-Suef University, Egypt. The study was done according to the Declaration of Helsinki. Informed consent contained all the steps of the study, risks and benefits was obtained from all patients or their parents (for young children) prior the study conduction.

Results

The current study included 30 patients: distributed as 15 males and 15 females with ages ranged from 15 to 47 years and an average of (25.93 ±10.5) years old. The mean preoperative angle was 44.3±8.8 DP, ranging from 25 to 60 DP. There was no postoperative significant residual angle in 12 patients (40%) immediately after the operation and throughout the follow-up period of 3 months but there were 18 patients (60%) with postoperative significant residual angle who were underwent adjustable sutures lysis by laser after conduction of strabismus operation then they were followed-up for 3 months.

Regarding the association between age, gender, and preoperative angle (DP) with postoperative significant residual angle. Patients' age was slightly older among patients with non-significant postoperative residual angle (28.67 ±10.6 years) versus patients with postoperative significant residual angle (24.11 ±10.3 years) with no statistically significant difference between both groups regarding their age (p-value=250). Gender distribution was almost equal between both groups with no statistically significant difference (p-value=0.645). Preoperative angle was slightly larger in patients with significant postoperative residual angle (45.28±8.7 DP) versus patients with no significant postoperative residual angle (42.92 ±9.2 DP) but this difference was not statistically significant (p-value =0.480).

Concerning the postoperative post-adjustment angle (DP) follow-up over a period of three months; the angle was significantly highest at the 1st (24) hours postoperative as compared with the angle measures on follow-up at one and three months. The mean angle at the 1st (24) hours was (9.67) vs. (5.56 and 4.06) at one- and three-months postoperative respectively with a statistically significant difference (p-values= 0.005 & <0.001) as compared with follow-up at one- and three-months postoperative, respectively. However, no statistically significant

difference in angle measure at one- and three-months postoperative (p-value >0.05) (table 1).

Regarding the comparison between postoperative significant residual angle and postoperative post-adjustment angle (DP) follow-up (1st 24 hours); there was a statistically significant decrease in the mean postoperative adjustment angle (DP) follow-up at (1st 24 hours) as compared with the mean postoperative significant residual angle (17.83 vs. 9.67) respectively with a statistically significant p-value (p-value =0.001) (Fig. 1).

Among the eighteen patients with postoperative significant residual angle; in 6 patients bilateral suture laser cutting was needed, and 12 patients needed unilateral cutting of the ripcord suture. Moreover, the mean postoperative adjustment angle (DP) follow-up at (1st 24 hours) was slightly lower among patients with unilateral suture laser cutting as compared with bilateral suture laser cutting; however, no statistically significant difference was detected (p-value >0.05) (table 2). In addition to the follow-up of the success rate of postoperative adjustment angle (DP) among those patients, there were 12 (66.7%) patients with succeeded adjustment after 24 hours, increased significantly to 16 (88.9%) after 1 month and one patient was added to them after 3 months of follow-up (table 3). The overall success was achieved in 12 patients without need to adjustable sutures in addition to 17 patients with residual angle were in need to adjustable sutures with argon laser use in release of adjustable sutures, the overall success rate became 96.7%.

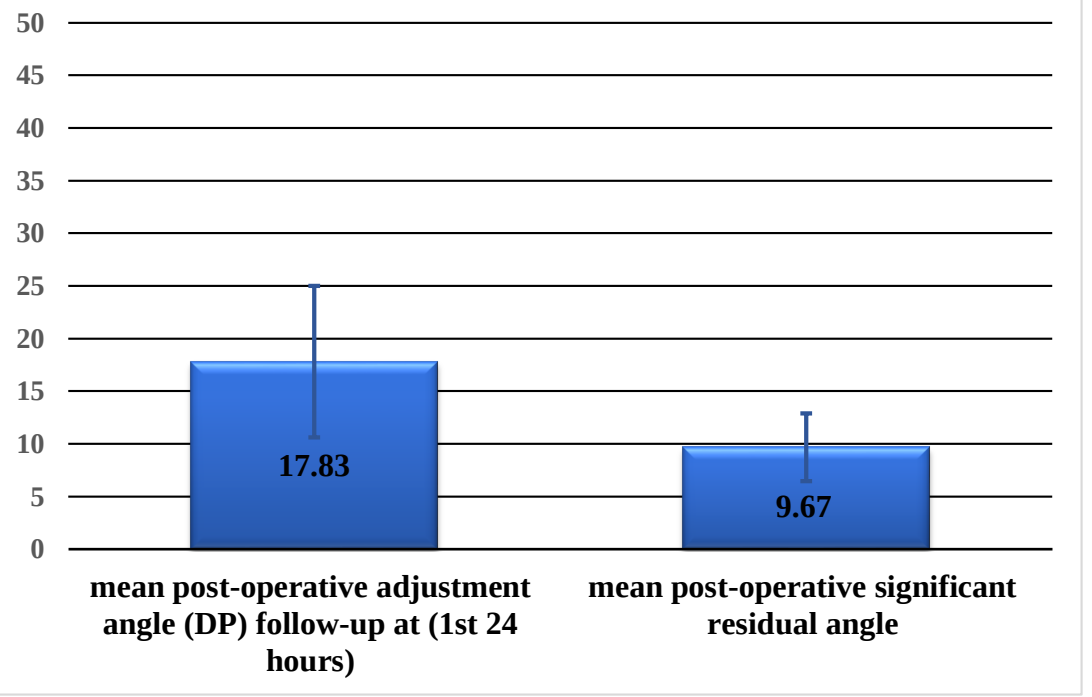


Figure 1. Comparison between postoperative significant residual angle and postoperative adjustment angle (PD) follow-up (1st 24 hours)

Table 1
Postoperative post-adjustment angle (PD) follow-up over a period of three months (N = 18)

	Mean±SD	95% CI for Mean		Minimum	Maximum	Overall p-value
		Lower Bound	Upper Bound			
In the 1st 24 hours	9.7±3.2	8.06	11.28	4	16	<0.001*
1 Month	5.6±4.7	3.23	7.88	0	16	
3 Months	4.1±4.6	1.78	6.33	0	16	

CI: Confidence Interval, SD: standard deviation
*P-value ≤0.05 is considered statistically significant.

Table 2
Postoperative adjustment angle (PD) follow-up at 1st 24 hours according to unilateral or bilateral suture laser cutting (N = 18)

Postoperative adjustment angle (PD) follow-up at 1st 24 hours	Cutting	N	Mean±SD	p-value
	Unilateral cutting	12	9.5±3.4	0.768
	Bilateral cutting	6	10±3.1	

Table 3
Success rate of postoperative adjustment angle (PD) follow-up

Success (N = 18)	Postoperative adjustment angle (PD) follow-up		
	1st 24 hours	1 month	3 months
Succeeded adjustment	12 (66.7%)	16 (88.9%)	17 (94.4%)
Failed adjustment	6 (33.3%)	2 (11.1%)	1 (5.6%)

Discussion

In our study, an adjustable ripcord suture was used in 35 lateral rectus recession out of 60 lateral rectus recession of 30 patients. On the same day, 12 (40%) patients were successfully aligned, and 18 patients (60%) had residual exotropia. 14 DP and 25 DP (mean 24.11 ±10.3 DP was the range of their residual angle of deviation. Out of the eighteen patients with residual angles, six patients required cutting of the suture for lateral recti muscles in both eyes and 12 patients required the cutting of suture on one side only. After release of the suture, all the muscles gained additional amount of recession except bilateral muscles of a patient of delayed cutting (24 h) and 12 patients (66.67%) aligned successfully, whereas 6 patients 1st day were still under corrected. After 3 months, only one patient was still uncorrected with success rate was 94% among patients with residual angles and the overall success rate was 96.7% among all patients in the study. The current study results were slightly higher than a recent study conducted by Hannon et al. (2020), who conducted the adjustable sutures on all

patients with residual exotropia, exophoria and orthophoria, their overall success rate at the end of the study was 88.1%, there were 5 patients with residual angle till the end of 6 months of follow-up (Hannon et al., 2020). The difference from our results is that we conducted the adjustable sutures with argon laser only on 18 patients with residual angle, also patients who had insignificant residual exotropia within 10 DP or orthophoric immediately after strabismus operation remained deteriorated till the end of follow-up period of 3 months. We selected patients with residual exotropia as the currently used technique has some drawbacks. First, it does not allow for postoperative adjustment titration. Second, lysis of adjustable sutures by argon laser may cause ocular pain so it should be done early postoperatively. Also, laser may induce burn of conjunctiva above or sclera under the ripcord suture. This may occur if high power is applied with many failed applications and it may also occur in the subconjunctival blood in the ripcord area. Moreover, in reported cases there was difficult cutting of the suture due to presence of tenon or subconjunctival hemorrhage (Chockalingam & Chirayath, 2007). Therefore, we prefer to reserve this technique for patients who significant postoperative residual exotropia not all patients with exotropia, exophoria and orthophoria.

The success rate in the current study was not so far from previous studies conducted by Coats (2001), who stated that the ripcord suture was applied in 12 patients; six patients had residual angles while five patients had successful adjustment postoperatively and only one patient failed to be corrected till the end of the study with overall success rate 92%. Also, Hakim et al. (2005), mentioned that after release of the suture, all the muscles attained additional recession and 15 children (83%) aligned successfully, whereas 3 children were still under corrected with the overall success rate was 94%.

On the other hand, some studies stated lower success rates than the present study as found in Chalifoux and others' study who reported the overall success rate for alignment at the end of 6 months postoperatively was 74.6% in using adjustable sutures (Chalifoux et al., 2016). Zhang et al. (2012), also mentioned the success rate in adult after 12 weeks postoperatively was 74.8% and the lowest success rate was noticed in Vasconcelos & Almeida (2015), who concluded that the success rate after 1 year postoperatively was 50.0% in patients with exotropia undergoing muscle recession with adjustable sutures.

In the current study, there was not any reported serious complication after using the adjustable sutures, as supported previously by Wabbels et al. (2013), who found that there was no serious complications as severe pain or discomfort during the adjustment when they asked after 10 years of the operation. In addition, it was reported that the adjustable sutures do not interfere the conjunctival healing significantly so, postoperative eye redness des not continue longer when compared with non-adjustable suture technique (Escardó-Paton & Harrad, 2009). On contrary to different studies who reported some complications during the adjustment as vagal stimulation, presence of postoperative inflammation (7%) and granuloma formation (1.7–13%) (Nihalani et al., 2009; Eustis et al., 2004).

Conclusion and limitations

The adjustable suture technique with argon laser assist can be beneficial in patients with residual exotropia after strabismus surgery with acceptable success rate and no significant complications, however our study has some limitations as the relatively low sample size and lack of comparison with other old techniques in the same study.

Availability of data and materials

We intend to share the study protocol as well as the individual de-identified participants' data. Data will be accessible through direct contact with the corresponding author, beginning 12 months and ending 24 months following article publication.

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