

# Adjustable Versus Non-adjustable Sutures in Strabismus Surgery in Patients with Thyroid Orbitopathy

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## SUMMARY

### Adjustable Versus Non-adjustable Sutures in Strabismus Surgery in Patients with Thyroid Ophthalmopathy

**Aim:** To evaluate the results of strabismus surgery in patients with thyroid ophthalmopathy. To determine whether adjustable suture surgery is beneficial for these patients.

**Materials and methods:** This study included patients who underwent strabismus surgery associated with thyroid ophthalmopathy from June 2010 to March 2012. During the observation period, 14 patients met the inclusion criteria. Seven patients underwent non-adjustable suture surgery (five women and two men) and seven patients underwent adjustable suture surgery (five women and two men). The patients' mean age was 63 years. The preoperative ocular findings were stable for at least one year in all cases. All strabismus surgeries were performed by one surgeon. The postoperative results were recorded at follow-up visits after 1 week, 1 month, 3 months and 6 months.

**Results:** In the non-adjustable suture case series, three patients were satisfied with the results (including one with a compensatory head posture). Two patients required reoperation and two prismatic correction. In the adjustable suture case series, no reoperation or prismatic correction was needed. In this group, all the patients were satisfied with the results (including one with a compensatory head posture).

**Conclusion:** Adjustable suture strabismus surgery in patients with thyroid ophthalmopathy proved to be beneficial. In our adjustable suture case series, there was a lower number of reoperations and prismatic corrections.

**Key words:** restrictive strabismus, thyroid ophthalmopathy, adjustable sutures, diplopia

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## INTRODUCTION

Endocrine orbitopathy (EO) is a chronic ocular disorder with a demonstrated linkage to thyroid autoimmunity. It most frequently afflicts patients with Graves-Basedow disease. However, it may also appear in patients with autoimmune thyroiditis, whether in the phase of hyperfunction or eufunction (5). Oculomotor disorders in EO appear in a certain phase of the disorder in 30 to 50% of patients, strabismus surgery is indicated in 9-15% of patients with EO (1, 21). The cause of oculomotor disorders and diplopia in the first phase is inflammatory swelling of the oculomotor muscles and subsequent their fibrotisation. Strabismus in EO therefore is classed as an incomitant strabismus (size of deviation of the strabismus is variable within the different directions of view). The treatment of this type of restrictive strabismus is difficult, reoperations or the necessity

for additional prismatic correction are no exception. One of the discussed possibilities for improve the postoperative results and reduce the risk of persistence of postoperative diplopia is the technique of operation using the method of adjustable sutures. We began using this method in our workplace from 2011 onwards.

The aim of our study was to retrospectively evaluate the results of restrictive strabismus operations by patients with endocrine orbitopathy, which we performed in our workplace in the period from June 2010 to March 2012. We focused on a comparison of postoperative results in a group of patients operated without adjustable sutures and in a group of patients operated on using a method with the use of adjustable sutures.

## MATERIAL AND METHOD

### Design of study

The study included patients who underwent surgery for restrictive strabismus

as a consequence of endocrine orbitopathy at the Eye Clinic of the Medical Faculty of Palacký University and University Hospital Olomouc in the period from June 2010 to March 2012. The preoperative examination included a complete eye examination on all patients (examination of the anterior segment, posterior segment, measurement of intraocular pressure, examination of motility, sonographic evaluation of oculomotor muscles, evaluation of the exophthalmos by a Hertel exophthalmometer) and endocrinological examination. In all cases the ocular finding before the operation was stable for a minimum of one year (evaluated using a Hess-screen, deviation measured by prisms, oculomotor muscles evaluated sonographically), the activity of the disorder had been dormant for at least one year (Clinical Activity Score 0) and the patient was endocrinological stabilised. All the operations were performed by one surgeon. Evaluation of the

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postoperative finding was conducted on the second day after the operation, and subsequently 1 week, 3 months and 6 months after the operation. Both the subjective satisfaction of the patient (perceived diplopia) and the objective ocular finding (position of eye and motility) were evaluated. The aim of all operations was to achieve clearance of diplopia in the direct angle of view and upon downward view.

### Surgical technique

All operations were performed under general anaesthesia. An incision of the conjunctiva was made in the case of fixed scleral sutures perilibbally, in the case of adjustable sutures directly above the muscle. The muscle was sewn with one Vicryl 6/0 suture with double threading and cut from the attachment. In the case of fixed scleral sutures we used a modification of the "hang-back" technique, known as "anchored hang-back". In the place of the required anchoring of the muscle, we fixed the muscle with superficial scleral sutures, with the definitive fixation performed by two deeper scleral sutures in the area of the original attachment. Upon use of the adjustable sutures technique we fixed the muscle only to the place of the original attachment by a "releasable suture". This suture can be loosened during adjustment, and the muscle can be contracted or relaxed according to requirement. At the end of the operation we fixed the ends of this suture to the eyelid. We performed the actual adjustment (relaxation or contraction of the muscle) according to the postoperative result 2 to 4 hours after the operation under local anaesthesia.

### Characteristics of study group

A total of 14 patients (10 women and 4 men) met the inclusion criteria and a

sufficient length of observation for the observed period. The average age of the patients was 63 years. 7 patients (5 women and 2 men) were operated without the use of adjustable sutures in the period from June 2010 to April 2011. In four cases a horizontal deviation was treated, and in three cases a vertical deviation. Another 7 patients (5 women and 2 men) were operated using the method of adjustable sutures in the period from May 2011 to March 2012. In this group a vertical deviation was treated in five cases, whilst two cases concerned a combination of a vertical and horizontal deviation.

## RESULTS

### Postoperative results

Upon an evaluation of the entire group of patients over six months from the operation procedure, an optimum result (clearance of diplopia in direct angle of view and upon downward view) without the necessity of prismatic correction or further reoperation was achieved in eight patients (57.1%). In two patients (14.3%) slight compensatory head position was required in order to attain a sufficiently large field of simple binocular vision. Nevertheless, the patients were satisfied with the result and did not wish for any further treatment. In two cases (14.3%) the target result was attained through the use of prismatic correction. A reoperation was indicated for 2 patients (14.3%), in both cases with a positive result.

In the group operated on without the use of adjustable sutures, the result was optimal in two patients (28.6%), slight compensatory head position was necessary in one patient (14.2%), reoperation was necessary in two cases (28.6%) and in another two cases (28.6%) prismatic correction was pre-

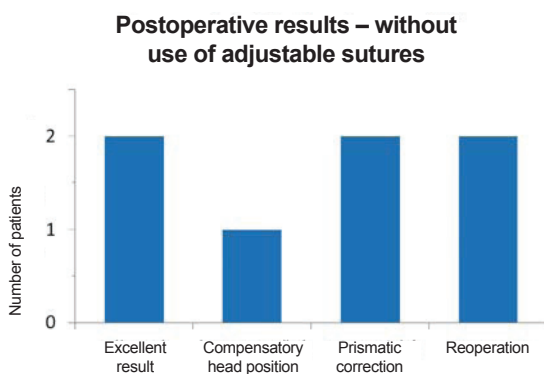
scribed (graph 1).

In the group of patients operated with the adjustable sutures method, neither reoperation nor prescription of prismatic correction was indicated in a single case. In six patients (85.8%) the result was optimal. In one case (14.2%) compensatory head position was required in order to attain a sufficient field of simple binocular vision upon downward view (graph 2).

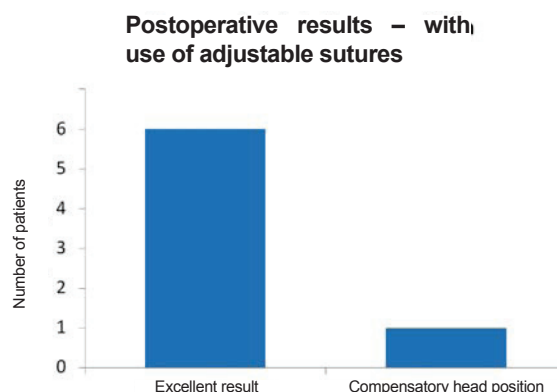
Analysis of performed procedures and recorded complications

A horizontal deviation was treated in four cases, always without the method of adjustable sutures. In one case the procedure succeeded in completely eliminating diplopia in all directions of view. In two cases the procedure was slightly undercorrected in its result, and prismatic correction was required. In one of these patients the postoperative results seemed to be good, and undercorrection of the performance with subsequent diplopia did not appear until the usage of the patient's own high myopia correction, thanks to its prismatic effect (fig. 1). Nevertheless, both patients were satisfied with the prismatic correction and did not wish for a further operation. This undercorrection of the performance was evident in both patients as early as 4 hours after the operation. Here the technique of adjustable sutures would unequivocally be of benefit. In one case the postoperative result was also good, nevertheless upon a follow-up examination after six months a vertical deviation had reappeared, which the patient is so far dealing with by compensatory head position (the patient does not desire prismatic correction or reoperation). The patient is a heavy smoker and smoked throughout the entire treatment and in the postoperative period.

In eight cases a vertical deviation was treated. In three cases this was without



Graph 1



Graph 2

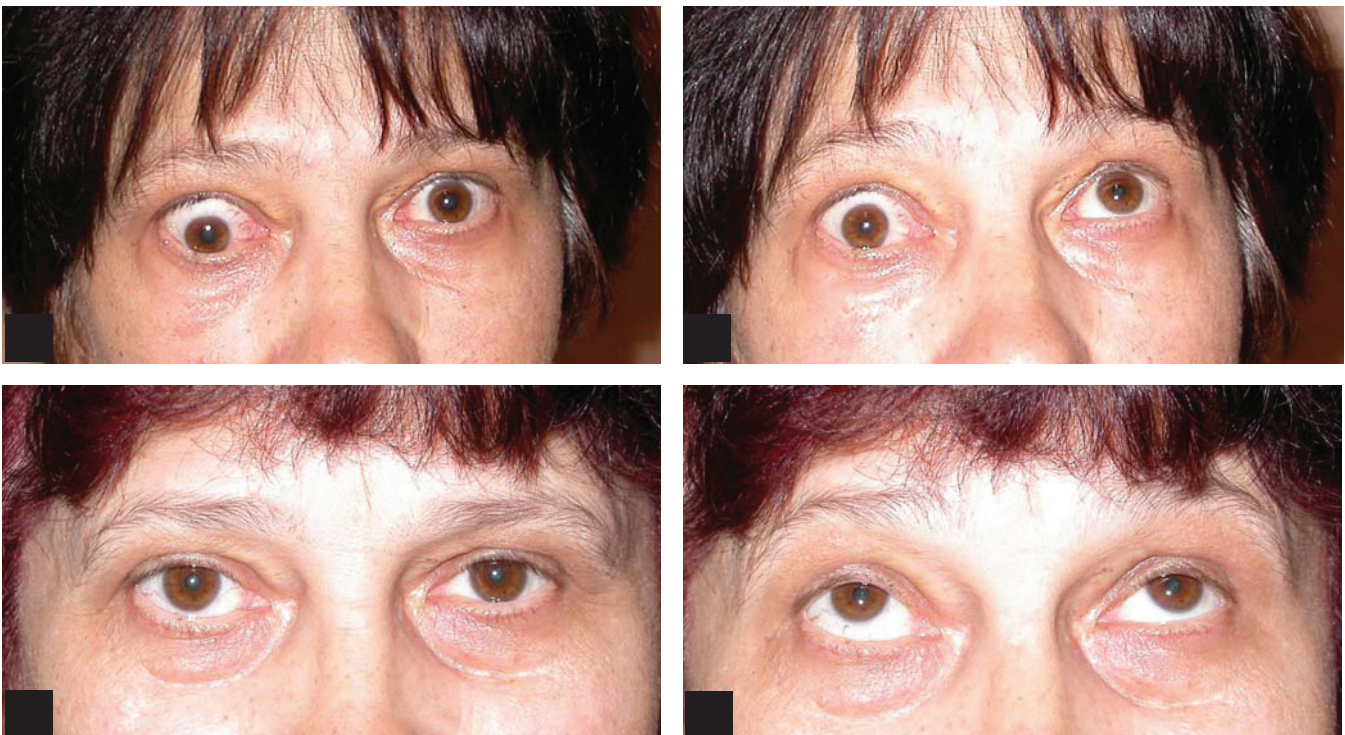


**Fig. 1** Patient with bilateral restriction of both internal rectus muscles, more in the left eye (a). After the operation parallel positioning was attained (b). After the usage of the patient's own high myopia correction there was a loss of fusion and diplopia reappeared (c). With prismatic correction the position of the eyes is parallel and the patient is without diplopia (d).

the use of adjustable sutures, in five with the application of this method. In four cases the results were excellent, without diplopia in the direct angle of view and upon reading (fig. 2). All four patients were operated on using the ad-

justable sutures method. We recorded late vertical hypercorrection in a total of two cases. In one case this was performed one week after the operation with the help of adjustable sutures. The probable etiology of the occurrence of this

complication is discussed below. The result was obstructive diplopia upon downward view. The patient dealt with the condition by a slight forward tilt of the head during reading. He was offered a further operation but has refused



**Fig. 2** Patient with considerable restriction of lower rectus muscle in the right eye before the operation upon forward (a) and upward (b) view. After retroposition of the lower rectus muscle in the right eye the position is parallel (c), motility is improved also upon upward view (d).

to date and is so far satisfied with the existing condition. In the second case, late vertical hypercorrection was not determined until 3 months after the operation in a patient operated without the use of adjustable sutures. The cause was contraction of the lower rectus muscle in the other eye. 9 months later retroposition of the lower rectus muscle was performed on the second eye using the adjustable sutures method, with an excellent result (fig. 3). Compensatory head position at a slight tilt persisted in one patient operated without the use of adjustable sutures (the patient did not wish for a further operation). In one patient also operated without adjustable sutures, the vertical deviation was well corrected postoperatively. Six months after the operation, however, a horizontal deviation appeared with a small residual vertical component. This condition required reoperation. We recorded retraction of the lower lid after retroposition of the lower rectus muscle to a

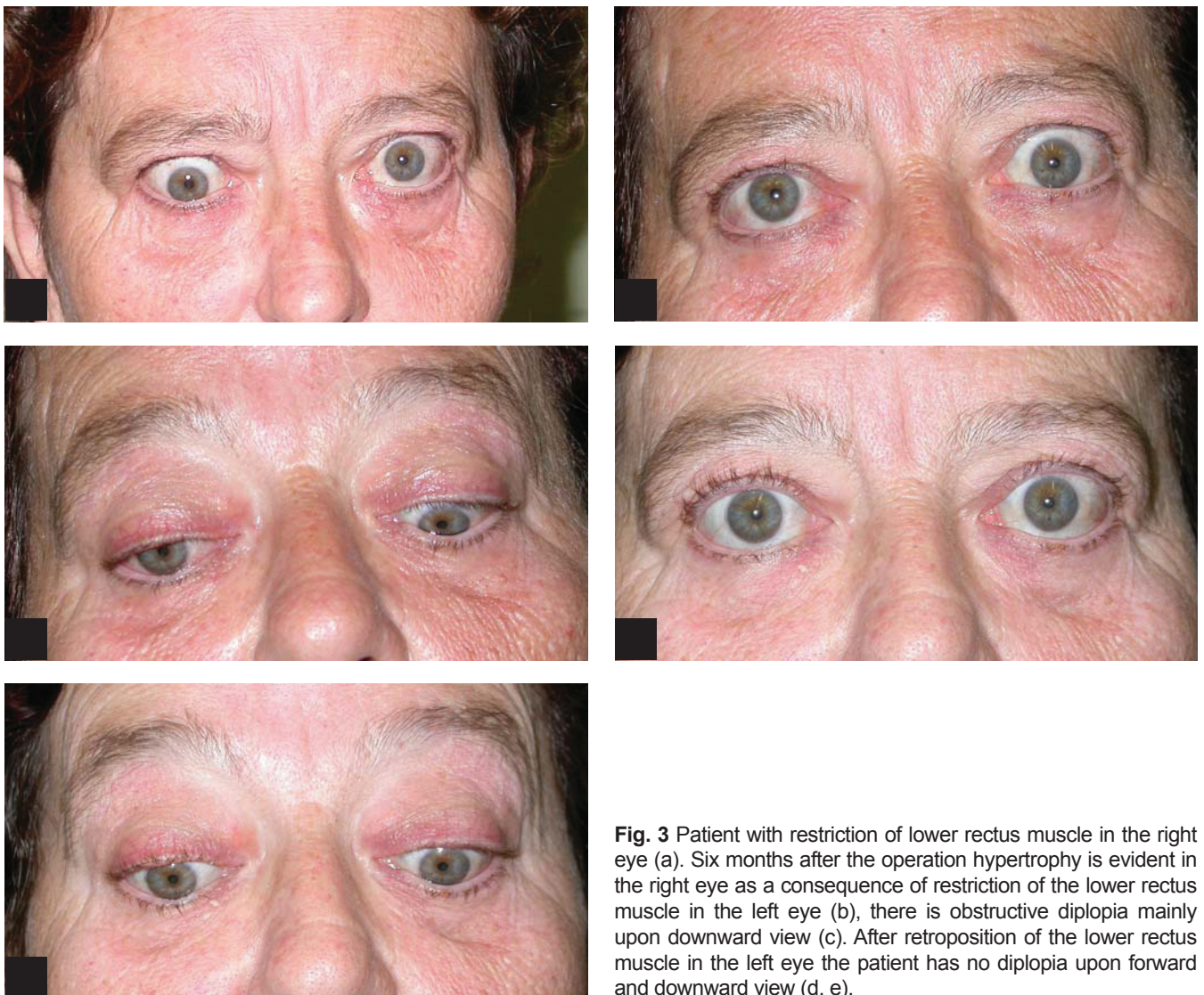
greater or lesser degree in all patients (fig. 2c, 4b). The patients did not wish to resolve the condition by means of cosmetic plastic surgery in any of the cases. Combined deviations (vertical and horizontal) were treated twice, in both cases by the adjustable sutures method with a good result (fig. 4).

## DISCUSSION

Restrictive strabismus upon endocrine orbitopathy in the final stage is caused by secondary fibrosis of the oculomotor muscles. For correct indication for surgical treatment it is very important to differentiate this type of strabismus from paralytic incomitant strabismus. Whilst in the case of paralytic strabismus the aim is to strengthen the function of the afflicted muscle (13, 18), in the case of restrictive strabismus we instead attempt to weaken the function of the afflicted muscle. In the great majority of cases we therefore perform retroposi-

on of the afflicted muscle. The surgical treatment of this type of strabismus in any case brings with it a whole range of potential pitfalls and questions.

It is very important to stipulate a time plan – i.e. when to operate on these patients. The first condition is for the patient to be stabilised overall. Close co-operation with an endocrinologist is absolutely essential (8). The ocular finding must be stable for at least six months (16). If we consider more than one surgical procedure, the strabismus should not be treated until after decompression of the orbit and before operation on the eyelids. Prohibition of smoking should also not be neglected. Smoking is unequivocally linked with a more severe course of endocrine orbitopathy (23, 25). Smokers with EO more frequently undergo decompression of the orbit and operations for restrictive strabismus (19). In our workplace we recommend waiting for at least one year after stabilisation of the condition before perform-



**Fig. 3** Patient with restriction of lower rectus muscle in the right eye (a). Six months after the operation hypertrophy is evident in the right eye as a consequence of restriction of the lower rectus muscle in the left eye (b), there is obstructive diplopia mainly upon downward view (c). After retroposition of the lower rectus muscle in the left eye the patient has no diplopia upon forward and downward view (d, e).



**Fig. 4** Patient with restriction of lower and internal rectus muscle in the right eye before operation (a). After their retroposition the positioning is parallel, the patient has no diplopia, there is evident postoperative retraction of the lower lid on the right (b).

mance of the operation (if the psychological condition of the patient so allows). In our patients we recorded a change in the position of the eyes in two cases during the course of six months even despite unequivocally adhering to this condition. In one patient we recorded a newly occurring restriction on the lower rectus muscle, thus a vertical deviation, for the second time after an operation on the horizontal muscles. In another patient, by contrast, after an operation on the vertical muscles a restriction appeared also on the internal rectus muscles over the course of time.

A further condition for successful surgery is correct identification of which muscle is afflicted. We most frequently encounter hypotrophy (affliction of the lower rectus muscle) or esotropia (affliction of the internal rectus muscle). However, restriction on more than one muscle is no exception. It is therefore always necessary to examine the motility of eyes both monocularly (duction) and binocularly (version). The basic examination also includes a cover test and measurement of the deviation using prisms. For the planning and successful performance of the operation procedure, a passive duction test is absolutely essential. It is possible to conduct this under local anaesthesia. In the case of a clear restriction diagnosed from the clinical picture it is possible to treat the patient for this condition. However, performance of a passive duction test should never be neglected in contentious cases. Due to compensation mechanisms, the restriction of the lower rectus muscle may sometimes imitate hyperfunction of the lower oblique muscle on the other eye (hypertrophy in adduction) or pseudoparalysis of the upper oblique muscle on the other eye (torticollis and tilting of the head towards the shoulders). Upon erroneous determination of diagnosis, an operation on the oblique muscles would have

catastrophic consequences in such cases (16). Similarly during surgery under general anaesthesia, the performance of a passive duction test and the evaluation of the degree of restriction of the individual oculomotor muscles is the basis for a good post-operation result, as shall be discussed later. We perform the test both at the beginning and at the end of the operation.

However, probably the most difficult matter is to decide by how many millimetres to perform the actual retroposition of the fibrotically altered muscles. The nomograms published to date, which are successfully used in the case of concomitant strabismus are based on an evaluation of the size of the deviation of the eyes. However, the use of these nomograms in strabismus surgery with EO, especially in the case of vertical deviations, frequently leads to failure and the necessity of a further operation. If the internal rectus muscle is markedly fibrotically altered, small retropositions do not have a very great effect. On the other hand, large retropositions may have a more marked effect than might be expected. Buckley (3) recommends the performance of larger retropositions on patients with EO for smaller deviations, and on the contrary for larger deviations recommends smaller retropositions than those according to the classic nomograms. In the case of vertical deviations the situation is even more complicated. It is necessary to remember above all that the most important factor for the patient and the patient's quality of life is to eliminate the diplopia not only in the primary position but also upon the downward view, during reading. In the case of a fibrotic lower rectus muscle, retroposition thereof is fully indicated. Nevertheless, if the patient has only small hypertrophy of the eye and suffers from diplopia only upon the forward view (and not downward), retroposition of the lower rectus muscle shall correct

the position in the direct angle of view, but may cause hypertrophy upon the downward view.

As a result some surgeons recommend performance of bilateral retroposition of the lower rectus muscle in these cases (as a prevention of this problem) (3). If the vertical deviation is large, both in the case of the direct angle of view and in the downward view, it is possible to combine retroposition of the lower rectus muscle with retroposition of the upper rectus muscle in the other eye. Another possibility is then to target the resulting position towards slight under-correction in the direct angle of view – patients mostly manage to eliminate this small residual deviation with the help of fusion mechanisms.

A number of innovative surgical procedures which could improve results, especially in vertical restrictive strabismus in EO, are also due to be published. Nguyen (17) recommends first of all evaluation of the degree of restriction of the individual muscles during surgery. After relaxation of the muscle from the sclera then dosing the size of the retroposition according to the other eye in such a manner as to ensure that the size of the largest possible passively performed duction in the given direction of view is the same in both eyes. Del Canto (6) states a success rate of up to 85% with another technique. He recommends determination of the place of the future fixation of the retropositioned muscle also during surgery. After relaxation of the muscle from the sclera it is suitable to leave the relaxed muscle to lie freely on the sclera and fix it in the place to which it adheres in the primary position of the eye. In our experience it is ideal to use a combination of both surgical procedures with the adjustable sutures method.

A number of techniques have been described for how to refix the muscle to the sclera. The technique of adjustable

sutures is frequently discussed. Some authors have demonstrated an improvement of postoperative results in various types of strabismus in adult with the use of this technique (4, 10, 11). Other studies have not succeeded in demonstrating the benefit of this technique (2, 24, 26). The published results of restrictive strabismus operations in the case of EO with the use of this method are variable (15, 28). Some authors recommend this technique in restrictive strabismus operations, whilst others point to its risks, in particular the danger of "slippage" of the fibrotically altered muscle.

In our sample, the technique of adjustable sutures was shown to be highly beneficial, and we recommend it. However, it is true that in comparison with adjustment in concomitant strabismus the adjustment of this type of strabismus seems more difficult for fibrotically altered rigid muscles. In our experience, muscles "relax" better and more simply than they "contract" in these cases. As a result, we primarily target the actual postoperative result towards slight undercorrection. We perform the actual adjustment 2 – 6 hours after the operation. We then always check the result of the adjustment with the patient's own correction by eyeglasses.

The possible complications upon strabismus surgery are generally known. Some of these (during operation and postoperative) are however typical precisely for patients with restrictive strabismus in the case of EO. They include especially the danger of loss of the muscle in the orbit during surgery, late vertical hypercorrection and last but not least alteration of the position of the eyelid.

With regard to the fact that muscles are frequently altered into rigid fibrotic strips, it is necessary to approach them far more carefully during the operation, and to avoid sharper pulling on the muscle without safe securing of the muscle. Careless handling can result in spontaneous rupture of the muscle (especially in the place of its attachment to the sclera). We did not record this complication in any cases in our patients.

Late vertical hypercorrection after reposition of the lower rectus muscle is one of the most frequent causes of the return of diplopia in patients with EO, with incidence stated at up to 50% (22). Unfortunately, it is not possible to resolve this problem even with the adjustable sutures technique. Hypercorrection does not occur until the later postoperative period. Hypercorrection which

occurs during the first two days to two months after the operation is probably caused by changes which take place as a result of the healing of the retropositioned muscle, in particular its adhesion to the sclera. One of the possible causes is considered to be "slippage" of the muscle after absorption of the suture. Upon use of a non-absorbable suture less hypercorrections were demonstrated in the early postoperative period (12). Hypercorrection which occurs two months or later after the operation is very probably caused by a restriction of the ipsilateral antagonist or contralateral lower rectus muscle. In mild cases prismatic correction helps, in more severe cases a further surgical procedure is necessary (16). In our study we recorded late vertical hypercorrection twice. In one case this occurred a week after an operation which used adjustable sutures, with the use of absorbable material. This experience led us to re-evaluate the surgical procedure. At present, during reposition of the lower rectus muscle using the adjustable sutures method, we have changed to the use of a non-absorbable suture. Upon repositions of other muscles we continue to use absorbable material. In the second case this complication did not occur until 3 months after the operation in a patient operated on without the use of adjustable sutures, as a consequence of contraction of the lower rectus muscle in the other eye.

Surgery on the upper and lower rectus muscle may lead to a change of position of the eyelid. We most frequently encounter retraction of the lower lid after reposition of the lower rectus muscle. Studies have been published which recommend performance of the maximum relaxation of the lower rectus muscle from the retractors of the eyelid and Lockwood's ligament during surgery as prevention against the occurrence of retraction of the lower eyelid (20, 7). On the other hand, this dissection may cause extensive scarring and thus increase the risk of occurrence of hypercorrection (27). In our study we recorded a certain degree of retraction of the lower lid in all patients after reposition of the lower rectus muscle. However, this was not so obstructive as to require plastic surgery in any of the cases.

The results of strabismus operations in the case of EO published in the international literature are very variable. The percentage of reoperations ranges from 17% to 45%. In the Czech professional literature only little space has been devoted to this issue to date. In gene-

ral it can be said that purely horizontal defects have the most favourable prognosis for restrictive strabismus in the case of EO. Vertical deviations have a less favourable prognosis, and the most difficult to resolve are combined deviations with numerous restrictions (16). In our study we attained unequivocally better results in the group of patients operated on using the adjustable sutures method. At the same time there was a higher representation of prognostically less favourable types of strabismus with numerous restrictions in this group. It is necessary to concede that a certain role here may be played not only by the change of surgical technique but also by the human factor. In treating these types of strabismus it is very important to gain experience from practice. The patients operated on by the adjustable sutures method were operated on later, therefore the surgeon had somewhat more experience. However, in the final result (after reoperation with prismatic correction) we also achieved very good results in the group operated on without the use of adjustable sutures.

On the basis of our experiences we recommend that great emphasis is placed also on patient education. Patients should always be familiar in detail with the course of the operation, and the possible risks and complications of the procedure should be clarified. Upon reposition of the lower rectus muscle we should not neglect to inform patients of the danger of occurrence of retraction of the lower lid. We should also always notify them of the possible need for a further operation, which may be required on the other "healthy" or "better" eye. We consider it entirely fundamental to emphasise the goal of the operation – i.e. the clearance of diplopia in the direct angle of view and upon downward view. It is appropriate to notify patients repeatedly that diplopia may persist in other directions of view. Unrealistic expectations may lead to patient dissatisfaction in the postoperative period, as well as frustration on the part of the surgeon. On the other hand, if the patient is instructed in detail and has realistic expectations, it may be a very pleasant surprise that the diplopia clears also in other directions of view.

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## CONCLUSION

Restrictive strabismus surgery on patients with endocrine orbitopathy using the adjustable sutures method was shown to be highly beneficial in our stu-

dy. In the group of patients operated on using this method we recorded a lower percentage of reoperations or the necessity for prismatic correction. On the basis of the results of our study and the information obtained from the literature, we have come to the following conclusions and recommendations, which we are applying in practice:

1. We do not perform restrictive strabismus surgery on patients with endocrine orbitopathy until the calm phase of the disorder. Before the operation the ocular finding must be stable for a minimum of 6 months if the patient's psychological condition so allows, and we recommend waiting for at least 1 year. No signs of EO activity

may be present. Disorder of the thyroid gland must be stabilised.

2. We emphatically prohibit smoking for patients.
3. During the operation on this type of strabismus we now unequivocally prefer the adjustable sutures method. We target the actual postoperative result primarily towards slight undercorrection. We perform adjustment 2 to 6 hours after the operation. We check the result of the adjustment always also with the patient's own correction by eyeglasses.
4. Upon reposition of the lower rectus muscle we perform only minimal posterior dissection.
5. We place great emphasis on tho-

rough patient education and emphasise the aim of the operation.

In general the most difficult step in restrictive strabismus surgery on patients with EO is correct timing of the procedure and the creation of a suitable operation plan. An essential precondition is very good knowledge of this issue. Upon adherence to the fundamental regulations (thorough examination, suitable operation plan and technique) it is now currently possible to achieve clearance of diplopia and restoration of a sufficiently large field of binocular simple vision in the majority of patients. The positive impact of a successfully performed operation on the quality of life of these patients is enormous (9, 14).

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