CASE REPORT

SUCCESSFUL MANAGEMENT OF HYPERTROPIA RELATED THYROID EYE DISEASE WITH HEMI HANG-BACK PROCEDURE

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ABSTRACT

Introduction: *Hypertropia in thyroid eye disease (TED) is uncommon condition which may cause visual and aesthetical problem with quality of life disturbance.*

Case Illustration: *A 44-year-old woman presented with a squint on the right eye with bilateral diplopia for 18 months. She had history of hyperthyroidism for two years which had been treated with thiamazole and propanolol for 1 year and methylprednisolone for 6 months. Visual acuity of both eyes was 20/20 with no sign of active inflammation and optic neuropathy. Ocular motility showed restriction in lateral and down gaze. Inferior restriction was found in forced duction test. Hypertropia of 40 prism diopters was remarkably seen in Krimsky test. We performed strabismus surgery after patient was in inactive stage and reach euthyroid state without treatment for 6 months. During surgery we found muscle enlargement and fibrous tissue of superior rectus muscle. Superior rectus recession for six milimeters with additional hemi-hang back procedure for two milimeters had been performed with significant improvement of diplopia. Ocular motility exercise was suggested to reach binocular vision.*

Discussion: *Hypertropia in TED was caused by extraocular muscle fibrosis due to inflammation and lymphocytic infiltration. Strabismus surgery was aimed at diplopia correction in primary position. Surgical procedure, extra ocular muscles in which surgery must be done and its surgical dosage should be considered carefully.*

Conclusion: *This case showed restrictive hypertropia in TED with distressing symptoms and challenging management. Hemi hang-back procedure is should be considered in difficult case.*

Keywords: *hypertropia, strabismus surgery, thyroid eye disease*

INTRODUCTION

Thyroid eye disease, also known as Grave's ophthalmopathy, is autoimmune inflammatory disorder mostly occurs with hyperthyroidism individually, although may also occur in euthyroid or hypothyroid. Typical ocular findings including eyelid retraction, eyelid edema, proptosis, chemosis, compressive optic neuropathy, and restrictive strabismus.[1] Restrictive extraocular myopathy develops in 40% cases, whereas some study report in various percentage between 15-51%.[1,3] Any extraocular muscle can be involved whereas inferior rectus is the most common involved, followed by medial rectus and superior rectus.[1,4] Pathogenesis of restrictive

extraocular myopathy begins with activation of orbital fibroblast and upregulation of pro-inflammatory cytokines which increasing synthesis of hyaluronan and glycosaminoglycan in acute phase. Extraocular muscle then become fibrotic and inelastic in healing process. In inactive phase, atrophy and fibrosis of muscle bundles are evident, with extension of fibrous strands in adjacent adipose tissue.[3]

Surgery principle in inactive TED is typically a multi-staged approached of sequential orbital decompression, eye muscle surgery, or eyelid surgery.[1,4] Not all patients require each step, and most of patient even do not need intervention. However, in patients who are unsuccessfully treated with prism or other non-surgical management, and patient with large degree of deviation may need surgical intervention.[3] Strabismus surgery in TED patient is aimed at restore binocular vision in primary and reading position.[3,5] Correcting restrictive strabismus caused by TED is challenging because there is no specific surgical technique that more superior than other. Moreover, the surgical dosing tables seems not to be as effective in patients with TED-associated strabismus. Unpredictable results and reoperation rate is also a common problem.[3]

Due to challenging nature of strabismus associated with TED, there are some special consideration in this patient including timing of surgery, careful examination and measurement of the deviation, and surgical technique decision. This case represents successful management of hypertropia which is considered to be rare manifestation of restrictive strabismus in TED.

CASE ILUSTRATION

A 44-year old-woman came to outpatient clinic complaining double vision in all gaze. There was no redness or swelling on both of eyelid nor blurry vision on both eyes. Patient didn't suffer pain on all gaze. Patient suffered squint on the right eye for 18 months. Two years ago she had history of hyperthyroidism and was treated with thiamazole and propranolol firstly. At that time patient had suffered proptosis and eyelid swelling, redness, difficult to close the eyelid and unable to move the eye in all direction of gaze. Patient was given methylprednisolone to reduce the inflammation process. Eyelid swelling, proptosis and redness was subsided but the double vision remained and vertical squint became remarkably seen. Hyperthyroid treatment was released after a year consumption and became euthyroid stable for 6 months without treatment.

Vital sign and general examination within normal limit. Ophthalmology examination revealed visual acuity of both eyes was 6/6 with normal IOP. Anterior segment examination revealed no sign of active inflammation (Fig 1). No found of eyelid hyperemia, no conjunctival

hyperemia, and no pain of eye movement. There was incomittant strabismus with restriction in lateral and downgaze of the right eye (Fig. 2). Distance and near Hirschberg test found 30^0 right eye hypertropia. Hypertropia of 40 prisms was remarkably seen in Krimsky test. WFDT showed vertical diplopia in near and far sight. Posterior segment was within normal limit in both eyes. T1 Head MRI revealed tendon sparring extraocular muscle enlargement of inferior, medial, and superior rectus in both eyes (Fig. 3).

Figure 1. Normal anterior segment of both eyes

Figure 2. Nine gaze before surgery

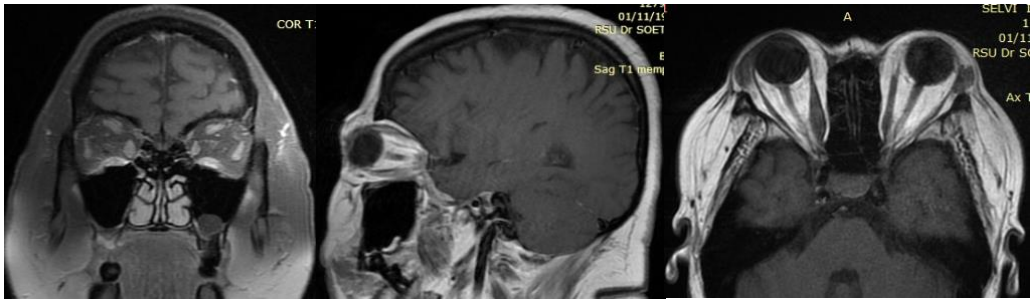

Figure 3. Patient's MRI showed muscle belly enlargement which is a pathognomonic sign of thyroid eye disease.

Strabismus surgery was planned after we diminished the need of orbital decompression after 6 months without any reactivation of the disease. We found inferior and medial rectus restriction in perioperative forced duction test. During surgery we found hypertrophy and fibrous tissue surrounding superior rectus muscle. Considering the location of superior rectus insertion, we calculated six millimeters superior rectus muscle recession with addition of two millimeters hemi-hang back procedure. We also released fibrous tissue of superior rectus. Resection was avoided to prevent ocular motility disturbance to downgaze caused by post procedural inflammation.

The following day patient confirmed that double vision was subsided, though she felt minimal pain in downgaze due to post procedural process. Ocular motility still showed restriction in downgaze and lateral gaze with marked improvement compared to pre-operative condition. We found right eye residual hypertropia of 15 prism diopters base down. (Fig 4). Visual acuity of both eyes was 5/5 and IOP was remain normal. Anterior segment examination found conjunctival hyperemia and sub-conjunctival bleeding. Fluorescein test was negative and anterior chamber showed no flare and cells. Post-operative treatment was topical fluoroquinolone and steroid, added with analgesic pro renata. Patient was discharged and suggested of ocular motility exercise to reach binocular vision.

Follow up one week after procedure, patient has no diplopia in primary gaze, but still complained diplopia in reading position. Hirschberg and cover test showed orthophoria in primary gaze. (Fig 5.) In 3 months, patient regained single vision both in primary and reading position. We also examined binocular function with TNO test and revealed 240 min of arc. Minimal limitation to inferior gaze and marked limitation to lateral and superolateral gaze still present. No sign of ocular inflammation and escalation in Clinical Activity Score as an adverse effect so far. (Fig 6.)

Figure 4. First day after surgery. Note the residual hypertropia of right eye

Figure 5. Nine gaze one week after surgery

Figure 6. Excellent improvement of ocular position in primary and down gaze 3 months after procedure

DISCUSSION

Grave's disease originally described as triad sign of orbital signs, hyperthyroidism and pretibial myxedema. Thyroid eye disease (TED) also known as Graves ophthalmopathy most often occurs in invidual with hyperthyroidism (90%), although may also occur in euthyroid (6%), Hashimoto thyroiditis (3%) or in primary hypothyroidism (1%). Typical ocular signs in TED included; (1) chemosis and/or caruncular edema, (2) restrictive strabismus in a typical pattern, (3) unilateral or bilateral eyelid retraction with typical lateral flare, (4) unilateral or bilateral proptosis compared with old photos of the patients, (5) compressive optic neuropathy, (6) fluctuating eyelid edema and/or erythema. In TED, the orbital manifestation does not necessarily parallel the activity of the thyroid gland or the treatment of thyroid abnormalities.[1]

Orbital fibroblasts play an active role in modulating the inflammatory process. These cells are located in the interstitial space between muscle fibers and within orbital fat and connective tissues. Orbital fibroblast is activated by T-cell bound CD154 and some contribution of thyrotropin receptor (TSHR) and IGF-1R. Several fibroblast pro-inflammatory cytokines then are upregulated, including IL-6, IL-8, and PGE2 which increasing synthesis of hyaluronan and glycosaminoglycan. Infiltration of hyaluronan and glycosaminoglycans which attract water osmotically causing marked expansion of endomysial space. Histopathologic studies of TED orbit reveal an extensive deposition of hyaluronan between muscle fibers, a widespread inflammatory infiltrate and an overabundance of cytokines.[2] Following infiltration of endomysial space by lymphocytes, macrophages, and neutrophils, muscle cells decrease and contractile properties of affected muscle may be compromised. Based on Rundle's curve, this active stage generally lasts from 18-24 months, but can present for up to 3 years (Fig 7.). In the healing phase, the muscle become fibrotic and inelastic, resulting in permanently restricted eye movement.[3] Despite reduced inflammation, permanent damage may occur and patients do not typically experience significant clinical improvement.[1,5] The disease then progresses to stable chronic, fibrotic, inactive disease. In inactive stage, atrophy and fibrosis of muscle bundles are evident, with extension of fibrous strands into adjacent adipose tissue.[1,3,5]

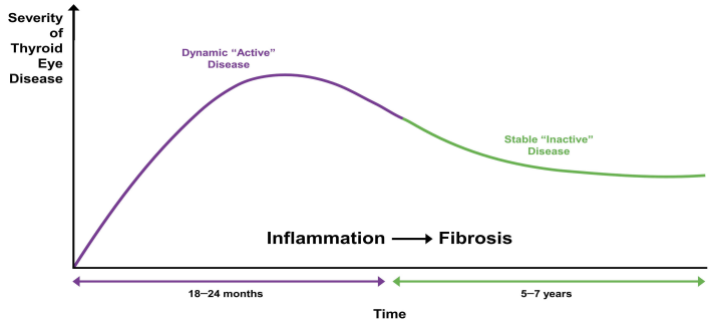

Figure 7. Rundle's curve as the clinical course of thyroid eye disease[5]

This case represent patient with history if hyperthyroidism 18 months ago with active ocular signs of thyroid eye disease, including eyelid edema, proptosis, and ocular motility disturbance. Patient was treated with thiamazole, propranolol and methylprednisolone to reduce the inflammation. After one year of treatment, inflammation subsided and thyroid hormone was normal, but strabismus was developed. Based on Clinical Activity Score, patient was then assessed as an inactive stage of TED by the presence of only eyelid swelling (CAS 1). In TED, diplopia occurs in 15-20% of cases and was seen up to 11 years after diagnosis. Patient's often complained worsening diplopia in particular gaze, since the strabismus in TED often highly

incomitant because of extraocular muscle restriction.[3] Any extraocular muscle can be involved, but inferior rectus is the most common involving muscle in thyroid eye disease (60-80%), medial rectus (42-44%) and followed by superior rectus muscle restriction.[1,4] Involvement of lateral rectus is rare, which should have considered to be another etiology such as myasthenia gravis. The condition is usually bilateral but often asymmetric.[3]

Neuroimaging of TED plays important role in the differential diagnosis and interdisciplinary management of patients with TED. Differential diagnosis of acquired strabismus in an adult includes cranial nerve palsies, orbital inflammatory conditions such as myositis and orbital pseudotumor and extraocular muscle involvement with systemic disease such as myasthenia gravis or chronic progressive external ophthalmoplegia.[3] In order to differentiate these acquired strabismic condition, orbital imaging with CT or MRI can be done to assess the extraocular muscles. MRI may help to detect disease activity and to predict the response of medical therapy.[1,3] T1 fat suppression post contrast MRI in this patient showed enlargement of the extraocular muscle bilaterally. In axial and sagittal MRI also showed tendon sparring extraocular muscle enlargement as a specific sign of TED. Specifically, in right eye, the restriction of superior rectus changed the ocular position upward.

Management of strabismus related to thyroid eye disease including surgical and non-surgical. In patient with no complaint of diplopia and instable strabismus, non-surgical management is more appropriate. A properly positioned Fresnel prism can relief diplopia in primary and down gaze. But in some patients, the degree of misalignment is too large or unstable of prism use. Botulinum toxin can be useful in hypertropia, with aa long lasting mean reduction of 10 PD achieved after two or three injection. Common complication after botulinum injection is iatrogenic ptosis.[3]

Surgery principle in TED is typically a multi-staged approached of sequential orbital decompression, eye muscle surgery, and/or eyelid surgery.[1,4] Surgery in TED should be undertaken during the inactive stage of the disease after the deviation is stable for 6 months.[1] Decompression surgery is aimed at reducing raised intraorbital pressure which responsible for optic neuropathy and severe exposure keratopathy caused by proptosis. Decompression surgery also has benefits to decrease intraocular tension, relief of pain and reduce preexisting strabismus deviation. Unfortunately, in some other cases, orbital decompression worsens the existing diplopia or even cause new onset strabismus.[6] Therefore, strabismus surgery is typically performed following decompression surgery.[3,4]

Strabismus surgery in TED is indicated in large degree of deviation that unsuccessfully treated with non-surgical management or in patient who is uncomfortable using prism. The

primary goal of strabismus surgery in TED is to restore binocular vision in primary and down gaze, secondarily to improve the window of single binocular vision.[1,3,5] In this case, the deviation is 40 PD which need a large amounts of correction and may be require additional resection or bilateral recession. The complexion of pathogenesis and disease course of TED makes the management become very challenging. In TED, the rectus muscles are often extremely tight and severe restriction can make exposure of the muscle more difficult because the globe does not rotate easily. Recession of muscle is more preferable. Resection of muscles may aggravate inflammation and best avoided as progressive fibrosis, especially in TED, of resected muscle may result overcorrection and new onset deviation that would be more difficult to reverse.[3,4] Though, some expert conclude that additional resection could be considered if, (1) large deviation that cannot be corrected with maximal recession, (2) limited to the tendon and, (3) the muscle appears to be uninvolved.[4]

Standard calculation for vertical deviation surgery was one millimeter recession equal to three prism diopters correction.[7] Surgical dosing table is often not effective in TED associated strabismus. The fibrous or inflamed extraocular muscle does not behave predictably to standard surgical normograms. A dictum described by Buckley and Von Noorden said that "more is less, less is more" which means the larger than expected recession for smaller deviation and smaller than expected recession for large deviation.[3] Recession in tight muscle using dosing table amounts may not show a significant post procedural correction because inadequate release of the restriction. On the other hand, larger recession can give more effect than expected results because of combination in both retroplacement of the muscle and relief of restriction.[3]

Another challenging problem in TED is no surgical technique produces has more accurate long term ocular alignment or which specific technique is more superior to the others. Many surgeons prefer adjustable suture strabismus surgery because of the perceived control it provides immediately after the procedure is done.[3] It has advantage of allowing fine tuning of ocular alignment within the first 24-48 hour after procedure when the muscle function has not completely returned and patient may still have residual effect of anesthesia. But, muscle adjustment requires pulling on the muscle and is often uncomfortable for the patient. Another disadvantage in this procedure is an under correction can occur in large recession, as the muscle will creep forward. This procedure is often indicated in complicated strabismus cases which has unpredictable results, paralytic strabismus, and large angle strabismus which standard surgical dose table do not apply.[9] Success rates of strabismus surgery in TED patients vary between 64-82% with adjustable sutures, compared to fixed sutures with success rate between 38-80%. However, adjustable suture procedure may be associated with higher rate of late

slippage of tight rectus muscle (especially inferior rectus). Over correction and scar elongation also reported in strabismus surgery using absorbable and adjustable suture.[10,11] Some surgeon advocate using conventional recession procedure in TED, which directly fixating the recessed muscle to sclera, to avoid late overcorrection as the complication in adjustable suture procedure.[12] Although undesirable alignments after surgery for TED strabismus is quite common and reoperation is not unusual (50% in TED strabismus), undercorrection are generally easier for patients to accept, and overcorrection is more problematic.[3,13]

Hang back procedure is not quite popular in TED patient with strabismus. Hang back procedure is often avoided because of its inherent instability and occurrence of central sag. The hang back procedure allows fixation of sutures anterior to the intended recession location, but has difficulty to be placed such as the presence of scleral buckle, cases with predisposed to scleral perforation, or in patient with thin sclera. Hang back is also useful for cases with difficulty to make a posterior scleral pass and the muscle is too tight that will retract posteriorly. In normal rectus muscle, recession using hang back procedure is approximately 6 mm, otherwise it is potential occurring late slippage or stretched scar because the muscle is not secured to sclera.[9]

Hemi-hang back procedure weakens extraocular muscles, which modification of conventional hang back technique, combines with traditional recession technique. This procedure is suitable in cases when recession expectation is more than 7mm. The advantages of hemi hang back procedure including more convenient surgical access and a reduction of side slipping potential or muscle creep, especially in large recession. This procedure is indicated in third and sixth nerve palsies, restrictive or tight muscle, and complicated forms of strabismus. This procedure can also perform in cases with difficult surgical exposure, thin sclera, presence of scleral scar, oblique muscle (particularly superior oblique tendon), scleral buckle, glaucoma implant, or other device on the sclera.[14] Readjustment in hemi hang back procedure is more uncomfortable as the technique requires more manipulation of globe and conjunctiva as the site of new insertion in posterior to original muscle insertion. The muscle is reattached to the sclera approximately half the distance between the original insertion site and the desired new recession position using single, absorbable suture.[15,16]

We used hemi hang back procedure in this patient considering the complexity of this cases. Firstly, superior rectus muscle restriction considered to be rare complication in TED. Superior rectus insertion is 7.7 mm far from limbus which more difficult to expose the muscle, moreover in tight muscle that need large recession. As we release fibrous tissue surrounding the superior rectus muscle, 6 mm recession with 2 mm hemi hang back is performed. Central

sag is not too long which minimize the chance of muscle instability. Hemi hang back is also give benefits in this case, especially in restrictive and tight muscle and thin sclera we found in this patient.

Residual strabismus after surgery is common problem in TED. It is important to emphasize the possibility of additional surgery and to inform that the goal of surgery is to eliminate double vision in primary gaze and reading position, not to complete relief of double vision in all direction. First day after surgery, patient had a residual 15 PD hypertropia. Routine ocular motility exercise plays role in this case, especially to restore fusion of both eyes. Additional surgery is considered if there is no improvement in 4-6 months after surgery. After 3 months, patient reach single vision in both primary and reading gaze. We also encourage patient to do routine ocular motility exercise to improve fusion in lateral gaze. Patient still under our observation to evaluate the possibility of reoperation since the restrictive process may continue to evolve over years.[3] Reactivation of TED after surgery, include decompression and strabismus surgery also reported in some cases, though it is very rare[5,17], so monitoring activity score and thyroid hormone regularly in TED patient is necessary.

CONCLUSION

Thyroid eye disease affects the eye and the orbit in various ways and is a common cause of acquired vertical deviation in adults, especially women. Restriction of extraocular muscle caused by edema inflammation and fibrosis due to lymphocytic infiltration. Any extraocular muscle can be affected, but superior rectus is considered to be rare. Strabismus surgery in TED is challenging, caused by complexity of the disease with chance of reactivation. Careful examination, measurement, and surgical decision were performed to improve the outcome.

This case represents successful management of hypertropia which is rare manifestation in TED associated strabismus. Hemi hang back procedure we choose in this patient reveals an excellent results and successfully achieved primary goal of strabismus surgery in TED.

References

1. Korn, L. B, Burkat, C.N., Carter, K. D., Perry, J. D., Setabutr, P., Steele, E. A., Vagefi, M.R. 2020. Thyroid Eye Disease in Oculofacial Plastic and Orbital Surgery. Basic and Clinical Science Course 2020-2021. American Academy of Ophthalmology. 2020;4: 75-85.
2. Shan S.J., Douglas R.S. The pathophysiology of thyroid eye disease. Journal of Neuro-Ophthalmology. 2014;34(2):177-85.
3. Douglas R.S., McCoy A.N., Gupta S. (editors). Strabismus in Thyroid Eye Disease in Thyroid Eye Disease. Springer; 2014 Nov 27; 99-
4. Wallang B.S., Kekunnaya R., Granet D. Strabismus surgery in thyroid-related eye disease: strategic decision making. Current Ophthalmology Reports. 2013 Dec;1(4):218-28.

5. Wang Y., Patel A., Douglas R.S. Thyroid eye disease: how a novel therapy may change the treatment paradigm. Therapeutics and clinical risk management. 2019;15:1305.
6. Bartalena L, Baldeschi L, Boboridis K, Eckstein A, Kahaly GJ, Marcocci C, Perros P, Salvi M, Wiersinga WM. The 2016 European thyroid Association/European group on Graves' orbitopathy guidelines for the management of Graves' orbitopathy. European thyroid journal. 2016;5(1):9-26.
7. Hered, R. W, Archer, S.M., Braverman, R. S., Khan, A. O., Lee, K., A., Lueder, G., T., O'Hara, M., A., Tarczy-Hornoch, K. 2020. Surgery of Extraocular Muscle in Pediatric Ophthalmology and Strabismus. Basic and Clinical Science Course 2020-2021. American Academy of Ophthalmology. 2020;14: 164-165.
8. Lioumi D, Gregson R. Late overcorrections in inferior rectus muscle surgery for vertical squint correction. Ann Ophthalmol. 2000;32:116–9.
9. Wright K.W., Strube, Y.N.J. Color atlas of strabismus surgery 4th edition. Springer Science Business Media, LLC; 2015.
10. Kerr NC. The role of thyroid eye disease and other factors in the overcorrection of hypotropia following unilateral adjustable suture recession of the inferior rectus (an american ophthalmological society thesis). Trans Am Ophthalmol Soc. 2011;109: 168–200
11. Peragallo JH, Velez FG, Demer JL, Pineles SL. Postoperative drift in patients with thyroid ophthalmopathy undergoing unilateral inferior rectus muscle recession. Strabismus. 2013 Mar 1;21(1):23-8.
12. Schittkowski, M., Fichter N., Guthoff, R. Strabismus surgery in Grave's disease dose effect relationship and functional results. Klinische Monatsblatter fur Augenheilkunde. 2004 Nov 1; 221(11):941-7
13. Mills MD, Coats DK, Donahue SP, Wheeler DT. Strabismus surgery for adults: a report by the American Academy of Ophthalmology. Ophthalmology. 2004 Jun 1;111(6):1255-62.
14. Odehnal M, Malec J, Hlozánek M. Hemi-hangback recession (retroposition) of extraocular muscles. Ceska a slovenska oftalmologie: casopis Ceske oftalmologicke spolecnosti a Slovenske oftalmologicke spolecnosti. 2004 Sep 1;60(5):356-61.
15. Agrawal S, Singh V, Yadav A, Bangwal S, Katiyar V. Modified adjustable suture hang-back recession: Description of technique and comparison with conventional adjustable hang-back recession. Indian journal of ophthalmology. 2017 Nov;65(11):1183.
16. Potter WS, Nelson LB, Handa JT. Hemihang-back recession: description of the technique and review of the literature. Ophthalmic Surgery, Lasers and Imaging Retina. 1990 Oct 1;21(10):711-5.
17. Xu L., Glass, L.R., Kazim M. Reactivation of thyroid eye disease following extraocular muscle surgery. Ophthalmic Plastic & Reconstructive Surgery. 2014 Jan 1;30(1):e5-6.