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Geriatric Patients are Predisposed to Strabismus following Thyroid-Related Orbital Decompression Surgery: A Multivariate Analysis

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Abstract

Geriatric patients (age ≥ 65) are prone to complications after surgery and are at risk for severe thyroid eye disease (TED). In this study, we aim to identify preoperative demographic and TED patterns associated with geriatric patients who underwent decompression surgery, to examine the effect of age on postoperative strabismus rates, and to identify factors that may contribute to postoperative strabismus in the geriatric subgroup. We retrospectively reviewed patients who underwent thyroid-related orbital decompression surgery at the Kellogg Eye Center, University of Michigan, between 1999 and 2014. Primary outcome was postoperative strabismus requiring palliation with prisms and/or strabismus surgery. Descriptive, univariate, and multivariable logistic regression analyses were used to define association of geriatric age with postoperative strabismus and determine predictors of postoperative strabismus. Of 241 patients, 41 (17.0%) were geriatric. They were less likely to undergo bilateral decompression (P = 0.012), less likely to be current smokers at time of decompression (P = 0.002), and more likely to have preoperative primary gaze diplopia (P = 0.001). Postoperative strabismus rates for geriatric patients (≥ 65 years of age), versus ages 50–65, 30–50, and < 30, were 73.2%, 41.3%, 31.9%, and 15.8%, respectively (P = 0.002). On multivariable analysis, geriatric age remained an independent risk factor for postoperative strabismus when compared to each age group (P ≤ 0.001). Among geriatric patients in subgroup multivariable analysis, balanced as opposed to lateral wall decompression (P = 0.038) and shorter TED duration (P = 0.031) were independently predictive of postoperative strabismus.

Keywords

Graves' disease; thyroid eye disease; decompression; geriatric; strabismus

INTRODUCTION

Thyroid eye disease (TED) is a potentially blinding and disfiguring disease that occurs most frequently in patients with Graves' disease. The incidence of TED is 16 cases per 100,000 per year for women and 2.9 cases per 100,000 per year for men, presenting most commonly

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in 40 year-olds and 60 year-olds, reflecting a bimodal distribution (more so in women).[1,2] Risk factors for severe disease include older age, male gender, smoking, and thyroid hormone dysregulation, while radioactive iodine without steroid prophylaxis has been associated with the development or worsening of TED.[1,3–7] Orbital decompression surgery is frequently necessary for a variety of indications and involves removal of one or more walls of the orbit (medial, inferior, or lateral walls) with or without deep bone contouring and orbital fat excision.[8] One of the most important complications of decompression surgery is postoperative strabismus, which generally occurs most frequently after medial and inferior wall decompressions (new-onset diplopia rates as high as 73%) and with lower rates in balanced and lateral wall decompressions, respectively.[9–12]

Despite the multitude of publications on TED and decompression surgery, however, we did not identify in our literature search any studies that examined the disease manifestations and surgical treatment course in geriatric patients (those with age ≥ 65 years). Elderly patients frequently have atypical presentations of disease and require higher-level care due to the presence of comorbidities, polypharmacy, and decreased physiological reserves.[13,14] Additionally, the number of older TED patients who undergo decompression surgery is likely to increase as the population ages and as anesthetic and surgical techniques improve.[13,14] Geriatric patients are also much more prone to complications after a variety of surgeries, resulting in significantly more morbidity and mortality compared to younger cohorts.[13,14] We hypothesize that geriatric patients are at increased risk of strabismus after orbital decompression surgery for TED. In this study, we aim to identify preoperative demographic and TED patterns associated with geriatric TED patients that underwent decompression surgery, to examine the effect of age on strabismus rates after decompression surgery, and to identify factors that may contribute to postoperative strabismus in the geriatric subgroup.

MATERIALS AND METHODS

Patient Selection

Our study was approved by the University of Michigan Institutional Review Board (No. 00040783) and we obtained all data retrospectively through review of the electronic medical record. All consecutive patients who underwent transorbital thyroid-related orbital decompression surgery at the Kellogg Eye Center of the University of Michigan from 4/21/1999 to 12/31/2014 were retrospectively reviewed. The patient list was obtained through orbital decompression billing codes. Patient exclusion criteria included the following: no preoperative or postoperative documentation, compressive optic neuropathy (CON), patients who underwent decompression surgery on both orbits using different techniques, patients who underwent more than one decompression on either orbit, and patients with no postoperative strabismus data (Figure 1). Each of the medical/surgical exclusion criteria represented possible confounding factors. Patients with CON were excluded as these patients underwent more aggressive treatment and surgical algorithms than patients without CON, making it more appropriate for them to be studied separately; in addition, vision loss may confound diplopia/strabismus outcomes. All surgeries were performed by one of six faculty surgeons of the Eye Plastic, Orbital and Facial Cosmetic

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Surgery Service. Preoperative evaluation was fairly standard, consisting of a complete ophthalmic exam and Humphrey visual field testing. The decision to operate rested with each surgeon, but was fairly standard over the course of the study period. Common indications for decompression surgery included severe proptosis with exposure and/or restrictive strabismus requiring muscle surgery (given that extraocular muscle surgery may worsen proptosis), orbital pain, and the presence of CON (although patients with CON were excluded from this study).[15]

Surgical Technique

Lateral wall decompressions were performed via upper eyelid crease or lateral canthus incisions. The approach was either superolateral or lateral. For the superolateral approach, a notch was carved into the rim, after which a Sumex drill (Stryker, Kalamazoo, Michigan) was used to achieve deep sphenoid bone contouring. For the lateral approach, some surgeons removed the orbital rim whereas others preferred to keep the rim intact but otherwise the approach was identical, with deep contouring of the sphenoid bone using the Sonopet Ultrasonic Aspirator (Stryker, Kalamazoo, Michigan). The deep sphenoid contouring extended between the superior and inferior orbital fissures. Fibrotic intraconal fat was sometimes removed to facilitate the decompression, typically from the inferotemporal and occasionally the deep superotemporal quadrant. When performed, .5 to 2.5 mL of fat was commonly removed (measured by volume in a syringe).

Medial wall decompressions were performed via retrocaruncular incision (between the caruncle and plica semilunaris) or via a transcaruncular incision. The deep medial wall posterior to the posterior lacrimal crest was exposed. The lamina papyracea was removed starting approximately 10 mm posterior to the posterior crest, extending posteriorly to the level of the posterior ethmoidal neurovascular bundle and the orbital process of the palatine bone. Bone removal was achieved using a combination of rongeurs and/or the Sonopet. In most cases, the orbital process of the palatine bone along with the posterior medial floor was also removed to further decompress the orbital apex. A primary aim of the medial decompression was to expand the posterior orbital space while preserving the overall vector of the anterior part of the rectus muscles.

Balanced decompressions comprised of lateral and medial wall decompression performed on the same orbit either sequentially during the same operation or in separate operations on separate days. When performed simultaneously, some surgeons prefer to decompress the medial wall first and others prefer to decompress the lateral wall first.

Covariates

Preoperative and intraoperative patient information collected included gender, age at time of surgery, unilateral or bilateral operation, surgeon, decompression technique (medial, lateral, or balanced), ethnicity (Non-Hispanic Caucasian, African-American, Asian-American, or another reported ethnicity), smoking status at the time of surgery ('current' if smoked in the year before surgery, 'quitter' if ceased smoking more than one year before surgery, or 'never smoker'), thyroid eye disease duration (from time of first onset of signs/symptoms characteristic of TED to time of surgery), diagnosed thyroid disease at the time of surgery

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(either hyperthyroid disease, hypothyroid disease, or no diagnosed thyroid disease), history of thyroid dermopathy (on ophthalmologist, endocrinologist, or dermatologist documentation), history of orbital radiation, prior history of decompression surgery on either orbit, prior history of strabismus surgery before decompression, history of radioactive iodine treatments, intravenous or oral steroid use in the 3 months before decompression, history of thyroidectomy, preoperative primary gaze diplopia (either continuous or intermittent), disease activity, adjunctive fat decompression, and preoperative proptosis averaged between the two orbits. Given that disease activity is a clinical diagnosis, patients were recorded as "active" or "inactive" based on surgeon documentation in assessment and plan section; instances in which surgeon did not explicitly document disease activity a computed clinical activity score less than 3 and six months of < 2 mm proptosis increase (if available) was used to defined "inactive," and documented exams that did not satisfy this criteria were considered "active."[16] Postoperative patient data we collected include prisms prescription and strabismus surgery and total follow-up length after decompression surgery. Balanced decompressions included both simultaneous and staged balanced decompressions.

Statistical Analysis

We defined geriatric as being 65 years of age or older at the time of orbital decompression surgery. The main outcome of interest was strabismus requiring palliation with prisms and/or strabismus surgery after completion of decompression surgeries. We first used descriptive and univariate statistics to describe baseline differences between geriatric and nongeriatric patients. We then stratified patients by postoperative strabismus outcome and used univariate statistical analysis to identify covariates associated with our outcome. We used the chi-square test or Fisher's exact test, as appropriate, for categorical outcomes, and independent t test and Mann-Whitney U test for normal and non-normally distributed continuous covariates, respectively. Shapiro-Wilk test was used to determine normality.

We then constructed a multivariable logistic regression model of postoperative strabismus to adjust for confounders of geriatric age, including decompression technique, surgeon, and preoperative diplopia status. The covariate 'preoperative primary gaze diplopia' was used to adjust for preoperative severity of strabismus. All covariates from the univariate analysis were included in the multivariable analysis and a backward elimination method with P value < .05 was used for variable retention.

We then conducted a geriatric subgroup analysis to determine predictors of postoperative strabismus among geriatric patients. Statistically significant independent predictors of postoperative strabismus from the multivariable analysis of the entire study cohort were included in the subgroup multivariable model. Each of the other covariates were then entered individually into the multivariable model and retained if statistically significant. Univariate and descriptive statistical analysis of the final covariates in the multivariable model were also conducted.

At all points of the analysis, tests were two-sided and P values < .05 were considered statistically significant. Unless stated otherwise, all continuous variables in the manuscript are presented as mean ± standard deviation. All statistical analyses were performed with commercially available software: SPSS version 22 (IBM Corporation, Armonk, NY).

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RESULTS

Overall, 241 patients were included in the analysis, 41 of whom were geriatric patients with age ≥ 65 years. The average age of the entire cohort was 52.40 ± 13.7 years. Forty-seven (19.5%) patients were male, and 194 (80.5%) patients were female. Of those who reported ethnicity, 188 (81.7%) patients were non-Hispanic Caucasian, 31 (13.5%) patients were African-American, 7 (3.0%) patients were Asian-American, and 4 (1.7%) patients were another reported ethnicity. At the time of decompression surgery, 214 (91.1%) patients were diagnosed with a hyperthyroid disease, 11 (4.7%) patients were diagnosed with a hypothyroid disease, and 10 (4.3%) patients had no diagnosed thyroid disease. Of patients with known disease activity status at the time of decompression surgery, 191 (79.6%) had inactive disease, while 49 (20.4%) had active disease. Median follow-up after decompression surgery was 16.3 months (Interquartile range, 6.3 – 33.4 months).

Table 1 compares demographic, medical, and surgical covariates between geriatric and nongeriatric patients. The average age of nongeriatric patients was 48.53 ± 11.6 years, while the average age of geriatric patients was 71.08 ± 5.4 years ($P < .001$). Geriatric patients were less likely to undergo bilateral decompression ($P =.012$), less likely to be current smokers ($P = .002$), and more likely to have preoperative primary gaze diplopia ($P = .001$).

Tables 2 and 3 show results of univariate and multivariable analysis of postoperative strabismus, respectively. The overall postoperative strabismus rate was 41.9%. On univariate analysis, postoperative strabismus rates for < 30 year-olds, 30–50 year-olds, 50–65 year-olds, and ≥ 65 year-olds (geriatric patients) were 15.8%, 31.9%, 41.3%, and 73.2%, respectively ($P < .001$). On multivariable analysis, geriatric age was an independent risk factor for strabismus when compared to each of the other age groups ($P \leq .001$). Other independent predictors of postoperative strabismus were preoperative primary gaze diplopia ($P < .001$), balanced relative to lateral wall decompression ($P < .001$), and TED duration by year ($P < .001$).

Table 4 shows results of geriatric subgroup analysis. In 41 geriatric patients, balanced relative to lateral wall decompression ($P = .038$) and TED duration by year ($P = .031$) were independent risk factors for postoperative strabismus. Preoperative primary gaze diplopia was not significantly associated with postoperative strabismus among geriatric patients on multivariable analysis ($P = .225$).

DISCUSSION

The goals of our study are to identify demographic and TED patterns associated geriatric patients age 65 and older who underwent decompression surgery, to examine the effect of age on strabismus rates after decompression, and to identify predictors of postoperative strabismus in the geriatric subgroup. Geriatric patients were less likely to undergo bilateral decompression and to be current smokers at the time of surgery, and more likely to have preoperative primary gaze diplopia. Geriatric age was an independent risk factor for postoperative strabismus, along with preoperative primary gaze diplopia, balanced as opposed to lateral decompression, and shorter TED duration. Among geriatric patients,

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balanced decompression (vs. lateral) and shorter TED duration were independently associated with postoperative strabismus. Geriatric patients should be counseled that they are at increased risk for strabismus after orbital decompression surgery.

Surgical studies from other specialties have shown that geriatric patients are at much higher risk of complications and mortality due to higher rates of comorbid systemic disease and the presence of geriatric syndromes such as malnutrition and cognitive and functional impairments.[14] Most of the studies, however, have examined cardiovascular, general, and orthopedic surgeries. A recent study examining cataract surgery in patients older than 90 years of age found no differences in postoperative visual acuity when compared to a younger control group, but did find that older patients had more comorbid systemic disease and intraoperative changes in systemic conditions.[17] This study also reported no correlation between age and intraoperative ocular complications.[17] More studies examining ophthalmology surgical outcomes in geriatric patients are warranted.

With regards to orbital decompression surgery, we found that geriatric patients were less likely to undergo bilateral decompressions. This may be due to a more conservative approach to surgery in the elderly, or possibly a higher occurrence of unilateral disease in the elderly. Additionally, the finding that geriatric patients are more likely to complain of primary gaze diplopia (53.7% vs 26.7%; $P = .001$) before decompression surgery is consistent with prior studies showing that age is positively correlated with severe TED and muscle-predominant TED.[5,18,19] However, after adjusting for preoperative primary gaze diplopia (a variable that should correlate with, and thus control for, preoperative degree of extraocular muscle involvement) in multivariable analysis, geriatric age remained an independent risk factor for strabismus after decompression surgery.

Previous studies have shown that older patients have smaller fusional amplitudes than younger patients, and this likely partially explains why geriatric patients tolerate postoperative strabismus more poorly.[20,21] It may be prudent, therefore, to involve adult strabismus specialists earlier in the care of geriatric patients, ideally before surgery. Additionally, minimizing other risk factors for postoperative strabismus such as using lateral wall decompressions or delaying decompression until a later date, giving the orbitopathy more time to stabilize, appear to decrease risk of postoperative strabismus in geriatric patients. The former suggestion is also supported by a recent prospective study which concluded that deep lateral wall decompression surgery with intraconal fat removal in the inactive phase of TED had no statistically significant effect on vertical or horizontal deviations as measured by an automated Hess screen.[11] Strabismus is a significant health concern for geriatric patients given that visual impairment confers an increased risk of falls in the elderly.[22,23] And finally, in the geriatric subgroup analysis, preoperative primary gaze diplopia was not predictive of postoperative strabismus likely because all geriatric patients, regardless of preoperative primary gaze diplopia, have increased risk of postoperative strabismus. In our study, 63% of geriatric patients without preoperative primary gaze diplopia developed postoperative strabismus, nonetheless. The sample size of our subgroup analysis was small, however, and a larger study population may yield more significant results. Further studies can also seek to incorporate extraocular muscle volume measurements and orbital anatomy factors into the analysis.

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Our study has important limitations. Firstly, our study is retrospective, and hence randomization to control for unforeseen confounders was not possible. Additionally, we did not adjust for multiple comparisons given the exploratory nature of the study and the use of multivariable analysis to adjust for confounders. Our study cohort consisted of patients with TED that underwent orbital decompression surgery, and all conclusions apply to similarly decompressed patients. The number of geriatric patients in our study was also relatively small, limiting the power of the subgroup analysis. Additionally, the study period was long, and changes in patient intake and preoperative treatments during the study duration that are not adjusted for by our covariates may confound the results. And also, 6 surgeons contributed patients to this study, and although we adjusted for surgeon in our analysis, this heterogeneity may nonetheless represent a confounder.

In conclusion, geriatric TED patients age 65 years and older who underwent orbital decompression surgery are at significant risk for strabismus after decompression surgery. When decompression surgery is indicated, using lateral wall decompression and avoiding operating during early temporal stages of TED may decrease the risk of postoperative strabismus. Earlier involvement of strabismus specialists may be beneficial for geriatric patients. Further studies individualizing TED care for geriatric patients are warranted.

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References

1. Wiersinga WM, Bartalena L. Epidemiology and prevention of Graves' ophthalmopathy. Thyroid. 2002; 12:855–60. [PubMed: 12487767]
2. Bartley GB. The epidemiological characteristics and clinical course of ophthalmopathy associated with autoimmune thyroid disease in Olmstead County, Minnesota. Trans Am Ophthalmol Soc. 1994; 92:477–588. [PubMed: 7886878]
3. Thornton J, Kelly SP, Harrison RA, Edwards R. Cigarette smoking and thyroid eye disease: a systematic review. Eye (Lond). 2007; 21:1135–45. [PubMed: 16980921]
4. Stein JD, Childers D, Gupta S, et al. Risk factors for developing thyroid-associated ophthalmopathy among individuals with Graves disease. JAMA Ophthalmol. 2015; 133:290–6. [PubMed: 25502604]
5. Perros P, Crombie AL, Matthews JN, Kendall-Taylor P. Age and gender influence the severity of thyroid-associated ophthalmopathy: a study of 101 patients attending a combined thyroid-eye clinic. Clin Endocrinol (Oxf). 1993; 38:367–72. [PubMed: 8319368]
6. Prummel MF, Wiersinga WM, Mourits MP, et al. Effect of abnormal thyroid function on the severity of Graves' ophthalmopathy. Arch Intern Med. 1990; 150:1098–101. [PubMed: 1691908]
7. Bartalena L, Marcocci C, Bogazzi F, et al. Relation between therapy for hyperthyroidism and the course of Graves' ophthalmopathy. N Engl J Med. 1998; 338:73–8. [PubMed: 9420337]
8. Boboridis KG, Bunce C. Surgical orbital decompression for thyroid eye disease. Cochrane Database Syst Rev. 2011; (12):CD007630. [PubMed: 22161415]
9. Ben Simon GJ, Wang L, McCann JD, Goldberg RA. Primary-gaze diplopia in patients with thyroid-related orbitopathy undergoing deep lateral orbital decompression with intraconal fat debulking: a retrospective analysis of treatment outcome. Thyroid. 2004; 14:379–83. [PubMed: 15186616]
10. Goldberg RA, Perry JD, Hortaleza V, Tong JT. Strabismus after balanced medial plus lateral wall versus lateral wall only orbital decompression for dysthyroid orbitopathy. Ophthal Plast Reconstr Surg. 2000; 16:271–77.

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11. Ben Simon GJ, Syed HM, Lee S, et al. Strabismus after deep lateral wall orbital decompression in thyroid-related orbitopathy patients using automated hess screen. Ophthalmology. 2006; 113:1050–5. [PubMed: 16751042]
12. Mourits MP, Bijl H, et al. European Group on Graves' Orbitopathy (EUGOGO). Outcome of orbital decompression for disfiguring proptosis in patients with Graves' orbitopathy using various surgical procedures. Br J Ophthalmol. 2009; 93:1518–23. [PubMed: 19028743]
13. Partridge JS, Harari D, Dhesi JK. Frailty in the older surgical patient: a review. Age Ageing. 2012; 41:142–7. [PubMed: 22345294]
14. Oresanya LB, Lyons WL, Finlayson E. Preoperative assessment of the older patient: a narrative review. JAMA. 2014; 311:2110–20. [PubMed: 24867014]
15. Gomi CF, Yang SW, Granet DB, et al. Change in proptosis following extraocular muscle surgery: effects of muscle recession in thyroid-associated orbitopathy. J AAPOS. 2007; 11:377–80. [PubMed: 17409001]
16. Mourits MP, Prummel MF, Wiersinga WM, Koornneef L. Clinical activity score as a guide in the management of patients with Graves' ophthalmopathy. Clin Endocrinol (Oxf). 1997; 47:9–14. [PubMed: 9302365]
17. Mutoh T, Isome S, Matsumoto Y, Chikuda M. Cataract surgery in patients older than 90 years of age. Can J Ophthalmol. 2012; 47:140–4. [PubMed: 22560418]
18. Regensburg NI, Wiersinga WM, Berendschot TT, et al. Do subtypes of graves' orbitopathy exist? Ophthalmology. 2011; 118:191–6. [PubMed: 20673587]
19. Wiersinga WM, Regensburg NI, Mourits MP. Differential involvement of orbital fat and extraocular muscles in graves' ophthalmopathy. Eur Thyroid J. 2013; 2:14–21. [PubMed: 24783034]
20. Palomo Alvarez C, Puell MC, Sanchez-Ramos C, Villena C. Normal values of distance heterophoria and fusional vergence ranges and effects of age. Graefes Arch Clin Exp Ophthalmol. 2006; 244:821–4. [PubMed: 16331485]
21. Winn B, Gilmartin B, Sculfor DL, Bamford JC. Vergence adaptation and senescence. Optom Vis Sci. 1994; 71:797–800. [PubMed: 7898888]
22. Patino CM, McKean-Cowdin R, Azen SP, et al. Central and peripheral visual impairment and the risk of falls and falls with injury. Ophthalmology. 2010; 117:199–206. [PubMed: 20031225]
23. Lord SR, Dayhew J. Visual risk factors for falls in older people. J Am Geriatr Soc. 2001; 49:508–15. [PubMed: 11380741]

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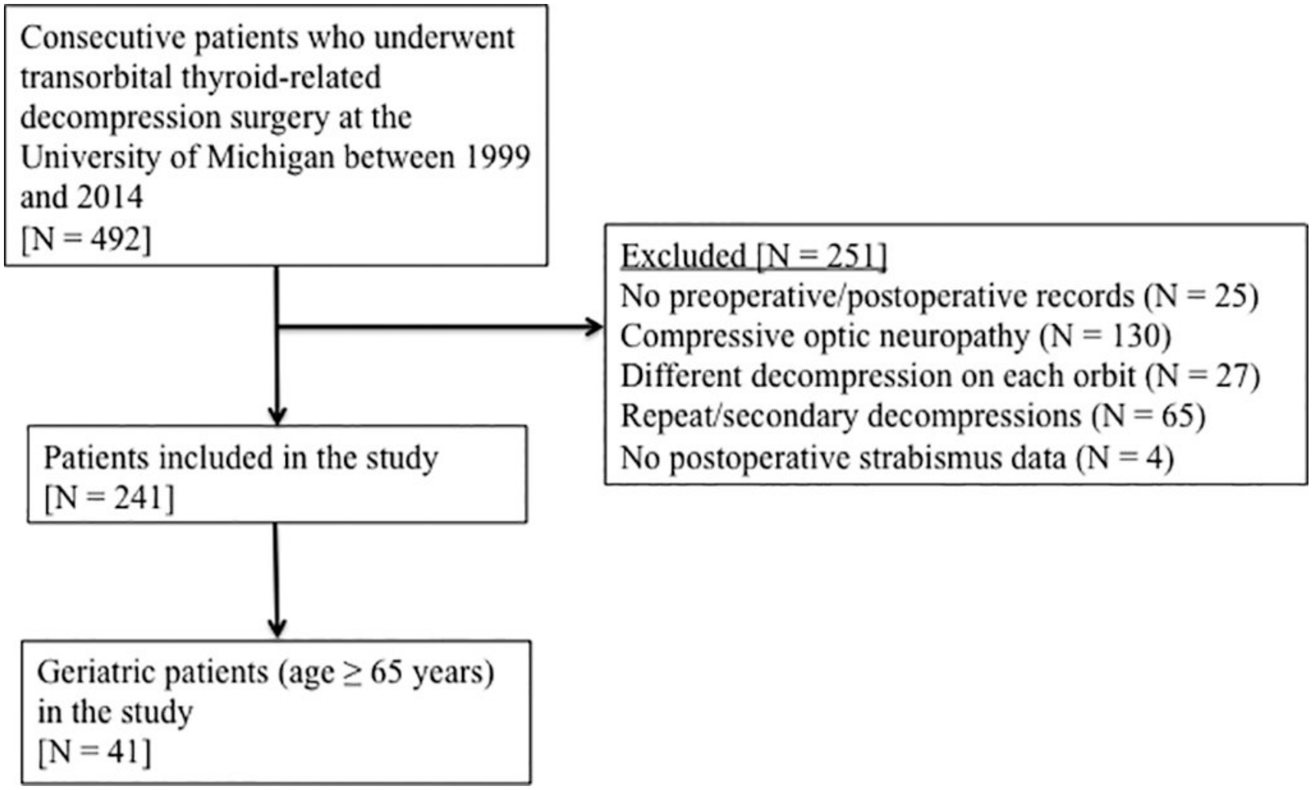

Figure 1.
Flow diagram showing patient selection.

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Table 1

Descriptive statistics and baseline differences between geriatric (age ≥ 65 years) and nongeriatric patients (age < 65 years). Continuous covariates are shown as mean ± SD and categorical covariates are shown as N (% of column total). Statistically significant P values are in bold.

Covariates	Nongeriatric [N = 200]	Geriatric [N = 41]	P value
Age (years)	48.53 ± 11.6	71.08 ± 5.4	**<.001**[a]
TED duration (years)	6.41 ± 7.0	5.83 ± 8.7	.093[a]
Preoperative proptosis (mm)	24.47 ± 3.2	23.45 ± 3.5	.072[b]
Bilateral operation	151 (75.5)	23 (56.1)	**.012**
Surgeon			.217[c]
A	20 (10.0)	7 (17.1)	
B	51 (25.5)	8 (19.5)	
C	5 (2.5)	3 (7.3)	
D	94 (47.0)	19 (46.3)	
E	2 (1.0)	1 (2.4)	
F	28 (14.0)	3 (7.3)	
Gender			.388
Male	41 (20.5)	6 (14.6)	
Female	159 (79.5)	35 (85.4)	
Walls decompressed			.528[c]
Medial	10 (5.0)	1 (2.4)	
Lateral	102 (51.0)	25 (61.0)	
Balanced	88 (44.0)	15 (36.6)	
Ethnicity			.490[c]
Non-Hispanic Caucasian	152 (80.4)	36 (87.8)	
African-American	27 (14.3)	4 (9.8)	
Asian-American	7 (3.7)	0 (0.0)	
Other	3 (1.6)	1 (2.4)	
Smoking status			**.002**
Current	75 (39.5)	5 (12.2)	
Quitter	41 (21.6)	16 (39.0)	
Never	74 (38.9)	20 (48.8)	
Thyroid disease			.725[c]
No thyroid disease	8 (4.1)	2 (4.9)	
Hyperthyroidism	176 (90.7)	38 (92.7)	
Hypothyroidism	10 (5.2)	1 (2.4)	
Dermopathy	7 (4.3)	4 (10.8)	.125[c]
Orbital radiation	9 (4.6)	1 (2.5)	1.000[c]
Past decompression surgery	18 (9.0)	1 (2.5)	.213[c]
Past strabismus surgery	16 (8.1)	7 (17.1)	.085[c]

Covariates	Nongeriatric [N = 200]	Geriatric [N = 41]	P value
Radioactive iodine	129 (67.2)	26 (63.4)	.642
Steroids	7 (3.5)	3 (7.3)	.381[c]
Thyroidectomy	30 (15.5)	5 (12.2)	.593
Preoperative primary gaze diplopia	52 (26.7)	22 (53.7)	**.001**
Active disease	38 (19.1)	11 (26.8)	.263
Adjunct fat decompression	146 (73.0)	35 (85.4)	.095

[a]Univariate comparisons made with the Mann-Whitney U test.

[b]Univariate comparison made with the independent samples t test

[c]Univariate comparisons made with the Fisher's exact test (all other categorical covariates analyzed with the chi-square test)

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Table 2

Descriptive statistics and univariate comparisons between covariates and symptomatic postoperative strabismus. Continuous covariates are shown as mean ± SD and categorical covariates are shown as N (%). Statistically significant P values are in bold.

Covariates	Total N (Column %)	Strabismus N (Row %)	P value
Total	241 (100.0)	101 (41.9)	
TED duration (years)[a]	231 (95.9)	99 (42.9)	**<.001**[c]
Preoperative proptosis (mm)[b]	241 (100.0)	101 (41.9)	.676[d]
Age (years)			**<.001**
< 30	19 (7.9)	3 (15.8)	
30–50	72 (29.9)	23 (31.9)	
50–65	109 (45.2)	45 (41.3)	
≥ 65	41 (17.0)	30 (73.2)	
Bilateral operation			.084
Yes	174 (72.2)	67 (38.5)	
No	67 (27.8)	34 (50.7)	
Surgeon			**.002**
A	27 (11.2)	17 (63.0)	
B	59 (24.5)	22 (37.3)	
C	8 (3.3)	6 (75.0)	
D	113 (46.9)	46 (40.7)	
E	3 (1.2)	3 (100.0)	
F	31 (12.9)	7 (22.6)	
Gender			.156
Male	47 (19.5)	24 (51.1)	
Female	194 (80.5)	77 (39.7)	
Walls decompressed			**<.001**[e]
Medial	11 (4.6)	3 (27.3)	
Lateral	127 (52.7)	37 (29.1)	
Balanced	103 (42.7)	61 (59.2)	
Ethnicity			.190[e]
Non-Hispanic Caucasian	188 (81.7)	84 (44.7)	
African-American	31 (13.5)	11 (35.5)	
Asian-American	7 (3.0)	1 (14.3)	
Other	4 (1.7)	3 (75.0)	
Smoking status			.699
Current	80 (34.6)	38 (47.5)	
Quitter	57 (24.7)	24 (42.1)	
Never	94 (40.7)	39 (41.5)	
Thyroid disease			.470[e]
No thyroid disease	10 (4.3)	6 (60.0)	

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Covariates	Total N (Column %)	Strabismus N (Row %)	P value
Hyperthyroidism	214 (91.1)	91 (42.5)	
Hypothyroidism	11 (4.7)	4 (36.4)	
Dermopathy			.220[e]
Yes	11 (5.5)	7 (63.6)	
No	188 (94.5)	81 (43.1)	
Orbital radiation			1.000[e]
Yes	10 (4.2)	4 (40.0)	
No	227 (95.8)	96 (42.3)	
Past decompression surgery			.056
Yes	19 (7.9)	4 (21.1)	
No	220 (92.1)	96 (43.6)	
Past strabismus surgery			.570
Yes	23 (9.6)	11 (47.8)	
No	216 (90.4)	90 (41.7)	
Radioactive iodine			.669
Yes	155 (66.5)	65 (41.9)	
No	78 (33.5)	35 (44.9)	
Steroids			**.019**[e]
Yes	10 (4.1)	8 (80.0)	
No	231 (95.9)	93 (40.3)	
Thyroidectomy			.700
Yes	35 (14.9)	14 (40.0)	
No	200 (85.1)	87 (43.5)	
Preoperative primary daze diplopia			**<.001**
Yes	74 (31.4)	60 (81.1)	
No	162 (68.6)	39 (24.1)	
Active disease			**.001**
Yes	49 (20.4)	31 (63.3)	
No	191 (79.6)	69 (36.1)	
Adjunct fat decompression			.730
Yes	181 (75.1)	77 (42.5)	
No	60 (24.9)	24 (40.0)	

[a]Mean TED duration for those with strabismus was 3.81 ± 4.7 years, while those without strabismus had mean TED duration of 8.19 ± 8.3 years.

[b]Mean preoperative proptosis for those with strabismus was 24.40 ± 3.6 mm, while those without strabismus had mean preoperative proptosis of 24.22 ± 3.1 mm.

[c]Univariate comparisons made with the Mann-Whitney U test.

[d]Univariate comparison made with the independent samples t test.

[e]Univariate comparisons made with the Fisher’s exact test (all other categorical covariates analyzed with the chi-square test).

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Table 3

Results of multivariable analysis showing independent predictors of symptomatic postoperative strabismus among 241 study patients. Statistically significant P values are in bold.

Covariates	Odds ratio	95% CI	P value
Age (years)[a]			
< 30	Reference	Reference	Reference
30–50	1.927	0.446 – 8.327	.380
50–65	2.306	0.530 – 10.025	.265
≥ 65	15.609	2.972 – 81.987	**.001**
Preoperative primary gaze diplopia			
Yes	11.664	4.911 – 27.702	**<.001**
No	Reference	Reference	Reference
Walls decompressed			
Medial	4.681	0.885 – 24.756	.069
Lateral	Reference	Reference	Reference
Balanced	6.778	3.080 – 14.916	**<.001**
TED duration (per year)	0.872	0.811 – 0.938	**<.001**

CI = confidence interval

[a] Geriatric patients had increased odds of postoperative strabismus compared to 30–50 year-olds (Odds ratio [OR], 8.101; 95% CI, 2.529 – 25.943; P value **< .001**), and compared to 50–65 year-olds (OR, 6.769; 95% CI, 2.292 – 19.988; P value = **.001**).

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Table 4

Results of geriatric subgroup analysis showing predictors of symptomatic postoperative strabismus among 41 geriatric patients. Statistically significant P values are in bold.

	Univariate Analysis			Multivariable Analysis		
Covariates	**Sample size N (% of total)**	**Strabismus N (row %)**	**P value[a]**	**Odds ratio**	**95% CI**	**P value**
Totals	41 (100.0)	30 (73.2)				
Walls decompressed			.624			
Medial	1 (2.4)	1 (100.0)		N/A	N/A	N/A
Lateral	25 (61.0)	17 (68.0)		Reference	Reference	Reference
Balanced	15 (36.6)	12 (80.0)		1051	$1.447 - 7.6 \times 10^5$	**.038**
Preoperative primary gaze diplopia			.179			
Yes	22 (53.7)	18 (81.8)		4.192	0.415 – 42.341	.225
No	19 (46.3)	12 (63.2)		Reference	Reference	Reference
TED duration (per year)[b]	39 (95.1)	30 (76.9)	.054	0.648	0.437 – 0.961	**.031**

CI = confidence interval

[a]Walls decompressed analyzed with the Fisher's exact test, preoperative primary gaze diplopia with the chi-square test, and TED duration with the Mann-Whitney U test.

[b]Mean TED duration for those with strabismus was 3.81 ± 4.3 years, while those without strabismus had mean TED duration of 12.58 ± 15.1 years.