Eye & ENT Research

RESEARCH ARTICLE OPEN ACCESS

Modified Deep Lateral Wall Decompression Surgery in the Treatment of Thyroid-Associated Ophthalmopathy: A Retrospective Evaluation

Shuo Wu[1,2] | Jiahong Lao[1] | Rongrong Ge[1] | Zhaohui Shi[1] | Qintai Yang[1]

[1]Department of Otolaryngology, The Third Affiliated Hospital, Sun Yat-sen University, Guangzhou, China | [2]School of Biomedical Engineering, Sun Yat-sen University, Shenzhen, China

Correspondence: Qintai Yang (yangqint@mail.sysu.edu.cn) | Zhaohui Shi (shizhh35@mail.sysu.edu.cn)

Received: 29 December 2024 | **Revised:** 22 December 2025 | **Accepted:** 2 March 2026

Keywords: deep lateral wall decompression | dysthyroid optic neuropathy | orbital decompression | thyroid-associated ophthalmopathy

ABSTRACT

Background: Thyroid-associated ophthalmopathy (TAO) may lead to severe exophthalmos and dysthyroid optic neuropathy (DON), which can threaten visual function. Orbital decompression surgery is often required when medical therapy is insufficient; however, traditional deep lateral wall decompression techniques remain associated with several complications.

Objective: To evaluate the clinical efficacy and safety of modified deep lateral wall decompression surgery in patients with TAO and DON.

Method: This retrospective single-arm study included sixteen patients who underwent modified deep lateral wall decompression at the Third Affiliated Hospital of Sun Yat-sen University between January 2022 and May 2023, with a 3-month postoperative follow-up. Postoperative assessments included visual acuity, intraocular pressure, exophthalmos, ocular motility, diplopia, and complications.

Results: At 3 months postoperatively, patients showed significant improvement in visual acuity, exophthalmos, and intraocular pressure ($p < 0.001$). The remission rate of postoperative limited ocular motility symptoms was 60% ($n = 10$). Among the twelve patients with preoperative diplopia, 6 showed improvement in symptoms. No cases of cerebrospinal fluid (CSF) leakage or vibration-induced diplopia occurred, and only one patient experienced temporary periorbital skin numbness, which resolved by 3 months.

Conclusion: The modified deep lateral wall decompression surgery shows promise as a potentially safer and effective treatment option for patients with TAO and DON, demonstrating improvements in vision, exophthalmos, and intraocular pressure with a low incidence of complications. However, these preliminary results warrant further validation in prospective or comparative controlled trials.

1 | Introduction

Thyroid-associated ophthalmopathy (TAO), also known as Graves' ophthalmopathy, is an autoimmune inflammatory disorder commonly associated with thyroid dysfunction and represents the most frequent orbital disease in adults. Progressive enlargement of orbital fat and extraocular muscles may lead to exophthalmos, diplopia, exposure keratopathy, and in severe cases, dysthyroid optic neuropathy (DON), which threatens irreversible visual loss. When medical therapy fails to control

Shuo Wu and Jiahong Lao contributed equally to the work and should be regarded as co-first authors.

Zhaohui Shi and Qintai Yang contributed equally to the work.

disease progression or optic nerve compression is present, orbital decompression surgery becomes essential for functional preservation and reconstructive purposes [1, 2].

Among various decompression approaches, deep lateral wall decompression has gained widespread use due to its substantial effectiveness in reducing exophthalmos and its relatively lower incidence of postoperative diplopia compared to other techniques. However, traditional deep lateral wall decompression still carries risks such as cerebrospinal fluid (CSF) leakage, periorbital skin sensory loss, and temporal fossa depression [3, 4].

Although traditional deep lateral wall decompression, typically performed via a transorbital approach with incremental bone removal from the inside to the outside, is effective, it has several limitations. When the deep orbital wall must be reached during surgery, damage to the zygomatic nerve, leading to periorbital skin numbness, is often unavoidable. The prolonged traction of orbital contents during surgery can also induce the oculocardiac reflex, causing sudden drops in heart rate and blood pressure, potentially leading to cardiac arrest and even jeopardizing the patient's life. Additionally, prolonged operation time can result in severe postoperative conjunctival congestion and edema. Furthermore, the lack of clear anatomical landmarks during the inside-to-outward approach makes it difficult to identify the dura mater and temporalis muscle, increasing the risk of postoperative complications such as CSF leakage and temporal fossa depression [5–7].

To address these issues, we propose a modified deep lateral wall decompression technique that removes bone progressively from the outside to the inside to optimize surgical access, minimize intraoperative trauma, and potentially reduce postoperative complications. This study aims to evaluate the clinical efficacy and safety of this modified technique, providing a possible improvement in surgical management for patients with TAO and DON.

2 | Materials and Methods

2.1 | Patient Population

A retrospective analysis was performed on the medical records of patients who underwent internal, external, and inferior wall orbital decompression surgery performed by the same surgeon at the Department of Otolaryngology, the Third Affiliated Hospital of Sun Yat-sen University, between January 2022 and May 2023. The study was approved by the Ethics Committee of the Third Affiliated Hospital of Sun Yat-sen University (II2025-105-01). Inclusion criteria: patients diagnosed with Graves' ophthalmopathy; clinical activity score (CAS) < 3, presenting with optic disc edema; steroid-insensitive; chronic, stable exophthalmos (exophthalmos change ≤ 1 mm in two consecutive follow-ups); patients with timely follow-up at 3 months postoperatively and with Hertel exophthalmometry records. Exclusion criteria: visual impairment due to head trauma or optic canal fracture; acute or unstable exophthalmos; exophthalmos caused by malignant tumors; patients lost to follow-up postoperatively.

2.2 | Study Design

Before surgery, all patients received high-dose intravenous steroids and antithyroid medication. Multidisciplinary consultations determined surgical necessity, and the lead surgeon chose the approach based on exophthalmos severity and symptoms. Preoperative and 3-month postoperative exophthalmometry were conducted by the same ophthalmologist using a Hertel exophthalmometer at a consistent angle to measure corneal surface-to-orbital rim distance. Data included visual acuity, intraocular pressure, diplopia and exophthalmos. Surgical duration was measured from the initiation of incision to the removal of the surgical drape, with the time recorded by the circulating nurse and verified by the anesthesiologist. Blood loss was assessed by both the surgeon and the anesthesiologist, and both values were documented in the surgical records. Postoperative CSF leakage, vibration-induced diplopia, and periorbital skin sensory loss were documented by otolaryngologists. Data were collected from patients' inpatient medical records and postoperative follow-up documentation.

2.3 | Surgical Technique

The surgery was performed under general anesthesia. A conventional approach using transnasal endoscopic decompression via the ethmoid sinus was employed for orbital and inferior wall decompression, preserving the anterior strut structure. The patient was positioned supine, rotated 45° to the contralateral side, and slightly reclined. A curved incision, approximately 2 cm in length, was made along the eyebrow arch toward the lateral orbital rim (Figure 1a). Subcutaneous tissue was dissected to expose the lateral orbital rim. Dissection proceeded along the lateral orbital wall, beneath the temporalis fascia, without entering the orbit. The temporalis muscle was detached from the surface of the orbital wall, and dissection continued downward to the point where the greater wing of the sphenoid bone turns laterally, exposing the junction of the greater wing of the sphenoid with the squamous portion of the temporal bone (the spheno-temporal suture) (Figure 1b), as well as the junction of the zygomatic orbital process and the greater wing of the sphenoid (the zygomatic-sphenoid suture) (Figure 1c).

Under nasal endoscopic visualization, the bony structures of the lateral orbital wall were gradually removed at the bending point of the greater wing of the sphenoid and the zygomatic orbital process until the orbital fascia was exposed (Figure 1d). The dura mater, orbital fascia, superior orbital fissure, and inferior orbital fissure served as the anatomical boundaries. The lateral orbital wall between the upper and lower orbital fissures was widely decompressed by removing the bone of the lateral orbital wall and greater wing of the sphenoid. This was done from the dura mater outward to the orbital fascia (Figure 1e). Following orbital decompression, the orbital fascia was incised radially, and a portion of the intraorbital fat was removed, allowing for the release of orbital contents into the newly created space formed by decompression of the lateral orbital wall (Figure 1f). After complete hemostasis, the temporalis fascia was sutured with absorbable sutures, and the wound was closed in layers, with sterile dressings applied to the surgical site. Postoperative 3D imaging of the bony structure is shown in Figure 2.

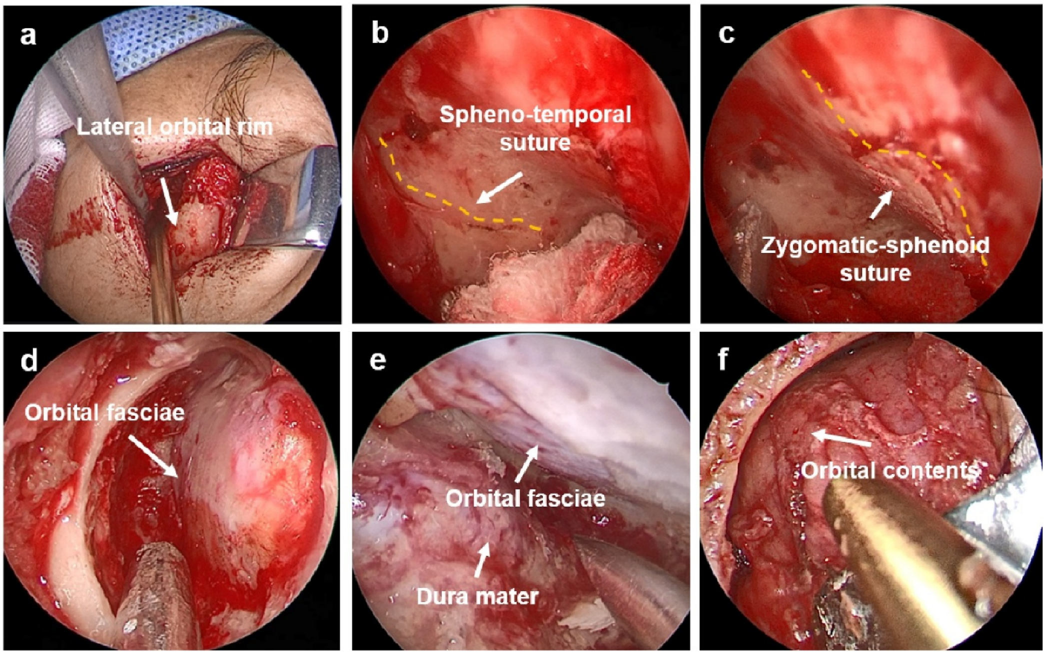

FIGURE 1 | Modified deep lateral orbital wall decompression procedure. (a) Curved incision at the lateral orbital rim. (b) Exposure of the spheno-temporal suture, located at the junction of the greater wing of the sphenoid and the squamous portion of the temporal bone. (c) Exposure of the zygomatic-sphenoid suture, at the junction of the zygomatic orbital process and the greater wing of the sphenoid. (d) Exposure of the orbital fascia. (e) Grinding down of the lateral orbital wall and the greater wing of the sphenoid bone. The outer boundary reaches the dura mater, and the inner boundary reaches the orbital fascia. (f) Radial incision of the orbital fascia, followed by removal of part of the orbital fat, allowing orbital contents to herniate into the newly created space after decompression.

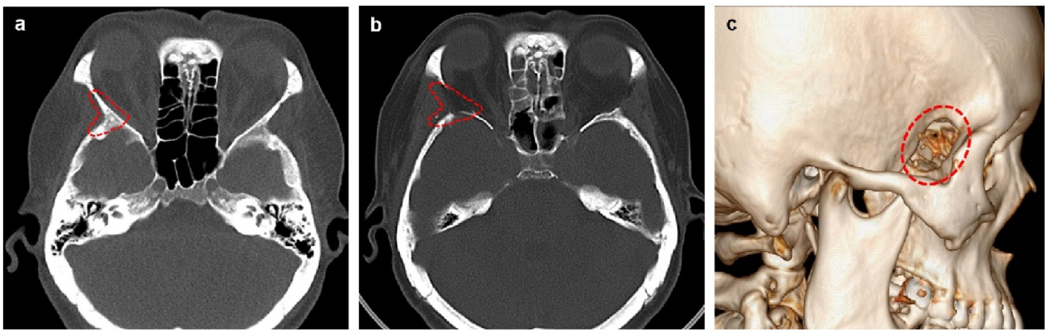

FIGURE 2 | Preoperative and postoperative orbital spiral CT examination. (a) Preoperative spiral CT. (b) Postoperative spiral CT at 4 days. (c) Four-dimensional reconstruction at 4 days postoperatively. Red dashed line indicates the decompression range on the right side in a representative case of bilateral modified deep lateral wall decompression (sphenoid door jamb region), illustrating the extent of bone removal. Quantitative volumetric annotation was not performed due to anatomical variability across patients.

2.4 | Data Analysis

Data analysis was performed using SPSS software version 27.0 (IBM Corp., Armonk, NY, USA). Continuous variables were assessed for normality using the Shapiro–Wilk test. Variables with a normal distribution are presented as mean ± standard deviation (SD), whereas non-normally distributed data are presented as median (interquartile range). Categorical variables are summarized as frequency and percentage (%). Preoperative and postoperative comparisons of continuous variables were conducted using the Wilcoxon signed-rank test, given the non-normal distribution of the paired data.

3 | Results

A total of sixteen patients who underwent three-wall orbital decompression with preservation of the orbital rim were included in this study, with ten patients diagnosed with TAO and six with DON. There were seven male and nine female patients. The average surgery duration was 320 min, and the average intra-operative blood loss was 50 mL (according to surgical and anesthesia records). 3 months postoperatively, patients showed significant improvements in visual acuity, intraocular pressure, and exophthalmos compared to preoperative levels (Table 1). Ten patients (62.50%) had limited eye movement preoperatively, and

TABLE 1 | Comparison of ophthalmic examination results preoperatively and postoperatively.

Parameter	Preoperative	Postoperative 3 months	z	p
Visual acuity	0.20 (0.15–0.40)	0.60 (0.58–0.73)	−3.53	< 0.001
Exophthalmos (mm)	24.50 (23.90–25.00)	20.50 (19.43–21.00)	−3.52	< 0.001
Intraocular pressure (mmHg)	24.00 (23.75–25.00)	20.00 (20.00–21.00)	−3.62	< 0.001

four patients (25.00%) had limited eye movement postoperatively. Twelve patients (75.00%) experienced diplopia preoperatively, and no new cases of diplopia occurred postoperatively. Of the twelve patients with preoperative diplopia, six (50%) showed relief of their symptoms. No cases of cerebrospinal fluid leakage or vibration-induced diplopia were observed postoperatively. One patient reported subjective numbness of the periorbital skin, which recovered to normal after 3 months. Preoperative and postoperative orbital spiral CT changes are shown in Figure 2.

4 | Discussion

Orbital decompression surgery is a complex procedure designed to reduce exophthalmos and relieve pressure at the orbital apex to preserve vision while minimizing surgical risks. Although several studies have proposed different approaches to the number of walls for decompression based on the degree of exophthalmos and the presence of optic nerve damage, no unified treatment guidelines have been established yet [8, 9]. For patients with severe exophthalmos and optic nerve compression, particularly those with DON, a three-wall or internal-external balanced decompression surgery is often required to prevent new-onset diplopia and effectively alleviate symptoms [10, 11].

In traditional deep lateral orbital wall decompression, the surgical field is gradually extended from the anterior orbital region to deeper parts. While this approach effectively relieves exophthalmos, it typically requires the removal of part of the orbital rim due to the bone grinding technique used from within the orbit to the outside, which may increase the risk of postoperative diplopia. More importantly, during orbital interventions, it is often necessary to separate the orbital fascia from the lateral bony structures, resulting in inevitable damage to the zygomatic nerve and its vascular bundle, which can cause periorbital numbness and other complications. Reports indicate that the incidence of periorbital numbness varies significantly [12, 13]. Additionally, extensive grinding of the zygomatic orbital process may lead to a large communication between the temporal fossa and the orbit, causing complications such as postoperative vibration-induced diplopia and temporal fossa depression. Vibration-induced diplopia occurs when contraction of the temporalis muscle during chewing or walking is transmitted to the eye, causing periodic diplopia, with an incidence rate ranging from 5.1% to 35% [14–16]. Temporal fossa depression primarily results from the atrophy of temporal fossa fat or damage to the temporalis muscle, with reported incidence rates varying, reaching up to 56% [14, 17]. In the present study, only one patient experienced transient periorbital skin numbness, which completely resolved within 3 months, suggesting that the modified outside-to-inside decompression strategy may effectively reduce zygomatic nerve-related sensory complications.

Siah et al. suggested that when grinding the external wall of the orbit from inside to outside, leaving a layer of bone to separate the orbit from the temporal fossa can effectively prevent these postoperative complications, or by implanting a reconstructive material in the external orbital wall, most cases of temporal fossa depression can be improved [18]. However, preserving the external orbital wall or implanting reconstructive material may limit the space available after decompression, thereby affecting the decompression effect [19].

In response to these issues, increasing attention has been paid to the effect of bone removal at the sphenoid door jamb (SDJ) on deep lateral orbital wall decompression. Studies have shown that bone removal at the SDJ is an independent predictive factor for the effectiveness of deep lateral wall decompression surgery [20, 21]. Therefore, the focus of decompression should be on the SDJ region, where removal of bone in this area can release more space while avoiding excessive bone removal associated with the zygomatic orbital process, thereby reducing the occurrence of postoperative complications. Our surgical strategy was therefore designed to prioritize bone removal at the SDJ while minimizing unnecessary manipulation of the zygomatic orbital process.

With the development of nasal endoscopy, in recent years, a nasal endoscopy-assisted deep lateral wall decompression surgery with preservation of the orbital rim has emerged, offering new approaches to reduce the risks associated with traditional surgeries [13, 22, 23]. Based on this, we propose a modified deep lateral wall decompression technique that removes bone from the greater wing of the sphenoid from outside to inside, while preserving the zygomatic orbital process bone. This method not only effectively reduces exophthalmos but also protects the zygomatic nerve and its vascular bundle, significantly lowering the incidence of periorbital skin numbness. The advantages of the modified surgery are primarily reflected in several aspects: First, the surgical path is optimized by removing bone from the outside to the inside, avoiding traction on the eye and thus reducing the risk of oculocardiac reflex. Second, most of the zygomatic orbital process bone is preserved, protecting the zygomatic nerve and vascular bundle, which decreases the incidence of periorbital numbness. Third, the procedure avoids large-scale removal of temporal fossa fat, reducing the risk of vibration-induced diplopia and temporal fossa depression. Consistent with these proposed advantages, our results demonstrated significant postoperative improvements in visual acuity, exophthalmos, and intraocular pressure at 3 months, with no cases of cerebrospinal fluid leakage or vibration-induced diplopia, and only one case of transient periorbital skin numbness. These findings support the safety and efficacy of the modified technique in reducing both functional impairment and procedure-related complications.

5 | Study Limitations

This study has several limitations. First, as a retrospective single-arm study without a control group using the traditional surgical approach, it is not possible to directly compare the outcomes or complication rates between the modified and conventional techniques. Second, the sample size was relatively small ($n = 16$), which may limit the statistical power and generalizability of the findings. Third, the follow-up duration was relatively short, with evaluation performed only at 3 months postoperatively. Therefore, the impact of ongoing inflammation in TAO patients, delayed complications, and long-term stability of surgical outcomes could not be fully assessed. In addition, although Figure 2 illustrates the decompression range with a red dashed boundary, individualized quantitative measurements of bone removal volume were not performed due to anatomical variability among patients in the sphenoid door jamb region. Future studies will incorporate standardized 3D CT volumetric analysis to quantify bone removal and establish correlations with clinical outcomes. Future research should include larger-sample, prospective randomized controlled trials with extended follow-up periods to validate the clinical advantages and long-term safety of this modified technique.

6 | Conclusion

This study preliminarily evaluated the clinical efficacy and safety of the modified deep lateral wall decompression surgery in patients with TAO. The results demonstrated improvements in visual acuity, reduces of exophthalmos, and decreased intraocular pressure following surgery. Additionally, postoperative complications were infrequent, and no severe adverse events, such as cerebrospinal fluid leakage, vibration-induced diplopia, or temporal fossa depression, were observed during the short-term follow-up period. These findings suggest that the modified technique shows promise as a potentially safe and effective surgical option for TAO patients; however, further prospective comparative studies with larger sample sizes and longer follow-up periods are needed to validate these preliminary results.

Author Contributions

Shuo Wu: conceptualization, data curation, formal analysis, writing – original draft. **Jiahong Lao:** data curation, methodology, writing – review and editing. **Rongrong Ge:** investigation, data curation. **Zhaohui Shi:** supervision, methodology, writing – review and editing. **Qintai Yang:** conceptualization, supervision, project administration, writing – review and editing.

Acknowledgments

The authors have nothing to report.

Funding

The authors have nothing to report.

Ethics Statement

This study was approved by the Ethics Committee of the Third Affiliated Hospital of Sun Yat-sen University (Approval No. II2025-105-01). The study was conducted in accordance with the Declaration of Helsinki.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data supporting the findings of this study are available from the corresponding author upon reasonable request.

References

1. W. Guo, J. Geng, and D Li, "Comparative Effectiveness of Various Orbital Decompression Techniques in Treating Thyroid-Associated Ophthalmopathy: A Systematic Review and Meta-Analysis," *BMC Ophthalmology* 24, no. 1 (2024): 526.

2. L. Bartalena, A. Pinchera, and C Marcocci, "Management of Graves' Ophthalmopathy: Reality and Perspectives," *Endocrine Reviews* 21, no. 2 (2000): 168–199.

3. M. R. Taher, T. Mohammadreza, B. SeyedMahbod, et al., "Orbital Anatomical Parameters Affecting Outcome of Deep Lateral Orbital Wall Decompression," *European Journal of Ophthalmology* 31, no. 4 (2021): 2069–2075.

4. J. Yu, Y. Chen, C. Xiong, Y. Wang, K. Yuan, and H. Liao, "A meta-analysis of the Efficacy of Two-Wall Orbital Decompression Operations for Thyroid-Associated Ophthalmopathy," *International Ophthalmology* 44, no. 1 (2024): 81.

5. H. Cansız, S. Yılmaz, E. Karaman, et al., "Three-Wall Orbital Decompression Superiority to 2-Wall Orbital Decompression in Thyroid-Associated Ophthalmopathy," *Journal of Oral and Maxillofacial Surgery* 64, no. 5 (2006): 763–769.

6. A. D. C. Leite, S. D. T. Pereira, J. Chiang, R. B. Moritz, A. C. P. Gonçalves, and M. L. R Monteiro, "Quality of Life in Patients With Graves' Orbitopathy Submitted to Orbital Decompression: Comparison Between Balanced and Inferomedial Techniques," *Arquivos Brasileiros de Oftalmologia* 87, no. 5 (2024): e20230296–e20230297.

7. D. T. P. Sousa, D. C. L. Almeida, C. K. Hiromi, et al., "A Randomized Comparative Study of Inferomedial vs. Balanced Orbital Decompression. Analysis of Changes in Orbital Volume, Eyelid Parameters, and Eyeball Position," *Eye (London, England)* 36, no. 3 (2021): 547–554.

8. K. P. Bernard, M. Piotr, J. Anna, et al., "Endoscopic Decompression of Orbit in Graves' Orbitopathy," *Polski Merkuriusz Lekarski: organ Polskiego Towarzystwa Lekarskiego* 46, no. 275 (2019): 224–228.

9. P. Tian, P. Zeng, H. Zhang, et al., "Balanced Medial-Lateral Wall vs. Selective 3-Wall Orbital Decompression for Sight-Threatening Graves's Orbitopathy: A Clinical Retrospective Cohort Study From 2016 to 2022," *European Archives of Oto-Rhino-Laryngology: Official Journal of the European Federation of Oto-Rhino-Laryngological Societies (EUFOS): affiliated With the German Society for Oto-Rhino-Laryngology - Head and Neck Surgery* 281, no. 9 (2024): 4807–4815.

10. J. Guo, X. Li, R. Ma, et al., "Correlation Between Uniocular Deviation and Duction Changes Following Different Decompression Surgeries in Thyroid Eye Disease," *BMC Ophthalmology* 21, no. 1 (2021): 134.

11. K. Safak and K Onur, "Surgical Treatment of Dysthyroid Optic Neuropathy: Long-Term Visual Outcomes With Comparison of 2-Wall Versus 3-Wall Orbital Decompression," *Current Eye Research* 41, no. 2 (2016): 159–164.

12. Y. Gong, J. Yin, B. Tong, et al., "Original Endoscopic Orbital Decompression of Lateral Wall Through Hairline Approach for Graves'

Ophthalmopathy: An Innovation of Balanced Orbital Decompression," *Therapeutics and Clinical Risk Management* (2018): 14607–14616.

13. B. Álvaro, G. Alicia, M. Enrique, et al., "Deep Lateral Wall Partial Rim-Sparing Orbital Decompression With Ultrasonic Bone Removal for Treatment of Thyroid-Related Orbitopathy," *Journal of ophthalmology* (2019): 9478512.

14. H. U. Olav, O. H. H, and R Eyvind, "Temporal Hollowing and Other Adverse Effects After Lateral Orbital Wall Decompression," *Acta Ophthalmologica* 94, no. 8 (2016): 793–797.

15. S. Oded, S. Khami, K. Michael, et al., "Comparison of Lateral Orbital Decompression With and Without Rim Repositioning in Thyroid Eye Disease," *Graefe's Archive for Clinical and Experimental Ophthalmology* 254, no. 4 (2016): 791–796.

16. I. Lykke and S Sven, "Evaluation of Quality of Life in Patients With Graves Ophthalmopathy, Before and After Orbital Decompression," *Orbit (Amsterdam, Netherlands)* 35, no. 3 (2016): 121–125.

17. H. U. Olav, R. N. M, R. Eyvind, et al., "Hyaluronic Acid Is Superior to Autologous Fat for Treatment of Temporal Hollowing After Lateral Orbital Wall Decompression: A Prospective Interventional Trial," *Journal of Plastic, Reconstructive & Aesthetic Surgery: JPRAS* 72, no. 6 (2019): 973–981.

18. W. S. Fong, B. P. Ck, and M Raman, "Surgical Management of temple-related Problems Following Lateral Wall Rim-Sparing Orbital Decompression for Thyroid-Related Orbitopathy," *British Journal of Ophthalmology* 100, no. 8 (2016): 1144–1150.

19. J. M. Clara, G. Zvi, C. K. Audrey, et al., "Lateral Wall Implant as an Adjunct to Lateral Wall Orbital Decompression in Severe Thyroid Eye Disease," *Ophthalmic Plastic and Reconstructive Surgery* 38, no. 2 (2022): 146–150.

20. S. Manvi, B. Kerr, P. Radhika, et al., "Impact of Sphenoid Trigone Size and Extraocular Muscle Thickness on the Outcome of Lateral Wall Orbital Decompression for Thyroid Eye Disease," *Oral and Maxillofacial Surgery* 28, no. 1 (2023): 307–313.

21. S. Kang-Jae, L. Shin-Hyo, H. Tae-Jun, et al., "Position and Size of the Sphenoid Door Jamb in the Lateral Orbital Wall for the Orbital Decompression," *Anatomy & Cell Biology* 52, no. 3 (2019): 242–249.

22. M. Purnima and O. D M, "Outcome of Deep Lateral Wall Rim-Sparing Orbital Decompression in Thyroid-Associated Orbitopathy: A New Technique and Results of a Case Series," *Orbit (Amsterdam, Netherlands)* 30, no. 6 (2011): 265–268.

23. S. Zhang, Y. Li, Y. Wang, et al., "Comparison of Rim-Sparing Versus Rim-Removal Techniques in Deep Lateral Wall Orbital Decompression for Graves' Orbitopathy," *International Journal of Oral and Maxillofacial Surgery* 48, no. 4 (2019): 461–467.