

Orbitotemporal Neurofibromatosis

Clinical Features and Surgical Management

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Purpose: To classify the periorbital deformities of adult orbitotemporal neurofibromatosis (NF) and describe new clinical findings, and to recommend guidelines for surgical treatment and management of surgical complications.

Design: Retrospective noncomparative case series.

Participants: Thirty-three patients over age 16 with orbitotemporal NF.

Methods: Retrospective surgical case record and serial photographic review recording the laterality and the severity of periorbital involvement, the presence of complications from previous surgery, the surgical techniques undertaken, and the surgical outcome and complications.

Main Outcome Measures: Comparison of preoperative and postoperative level of deformities.

Results: New classification of periorbital deformities: (1) brow ptosis, (2) upper lid infiltration with ptosis, (3) lower lid infiltration, (4) lateral canthal disinsertion, and (5) conjunctival and lacrimal gland infiltration. Two patients had bilateral and 31 patients (94%) had unilateral orbitotemporal NF. All patients had upper and 19 patients (58%) had lower lid involvement. Six (18%) patients had significant brow infiltration. Fourteen (42%) patients had a dropped lateral canthus requiring surgical reattachment, 28 (85%) required anterior levator resection for ptosis, and 28 (85%) had lid-debulking surgery. New findings included severe brow infiltration, lacrimal gland involvement, and functional nasolacrimal duct obstruction. Complications from previous surgery included residual ptosis, ptosis overcorrection, poor lid contour, dry eye, corneal exposure, and upper and lower lid entropion/ectropion.

Conclusions: The periorbital appearance and comfort of patients with NF type 1 who have orbitotemporal NF can be significantly improved through oculoplastic surgery. *Ophthalmology* 2004;111:382-388 © 2004 by the American Academy of Ophthalmology.

Neurofibromatosis type I (NF1) is an autosomal dominant inherited disorder inherited with a frequency of 1 in 3000 to 4000¹ live births. The incidence of head and neck involvement ranged from 1% to 22%^{2,3} in published literature. The orbitotemporal deformities, which might cause severe disfigurement, pose a major challenge to orbital and oculoplastic surgeons. Whereas the orbital manifestations and management have been well classified by Jackson et al,⁴ the management of periorbital and palpebral aspects of the disease has been less well documented and forms the focus of this article.

Materials and Methods

The study was a retrospective interventional case series review of patients older than 16 years treated by one of the authors (JROC).

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All consecutive adult patients older than age 16 years with orbitotemporal NF who underwent surgery for periorbital deformities between 1978 and 1999 were included in this study. Pediatric patients younger than 16 years required a different management approach.⁵ The following variables were derived from the case notes: the age and gender of the patient; previous lid and/or orbital surgery; the dates of initial examination; surgery and latest follow-up; the extent, side, and type of brow/upper/lower lid infiltration; the presence of upper and lower lid ectropion/entropion; and conjunctival or lacrimal gland infiltration. All the patients had preoperative and postoperative photographs (Table 1). All patients were followed up for a minimum of 1 year after surgery.

Results

Thirty-three patients (14 males and 19 females) first seen over a 22-year period between 1978 and 1999 inclusive were included in the study. Their ages ranged from 16 to 58 years. Preoperative and postoperative photographic records were available for all patients. Fourteen (42%) of the patients had undergone previous lid surgery, and 1 had undergone previous orbital surgery. The following clinical patterns were found. Most of our patients had unilateral disease (94%, 16 left-sided and 15 right-sided disease). Two patients had bilateral disease. All patients had upper lid disease, and 19 (58%) had lower lid disease. Twenty patients were in Jackson group 1 (orbital soft tissue involvement with a seeing eye), 9 in Jackson group 2 (orbital soft tissue and significant bony involvement with a seeing eye), and 4 in group 3 (orbital soft tissue and

Table 1. Anatomy of Orbitotemporal Neurofibromatosis Involvement, Jackson Group, and Type of Surgery Undertaken in study patients

Patient	Gender	Right/Left	Brow Infiltration	Jackson Group	Upper Lid Infiltration	Lower Lid Infiltration	Ptosis Surgery	Lid Debulking	Lateral Canthal Reattachment
1	F	L		2	+	+	+	+	+
2	M	R	+	3	+	+	+	+	+
3	F	B	+	1	+	+			
4	M	R		1	+	+	+	+	+
5	M	L		1	+	+	+	+	+
6	F	L	+	2	+		+	+	+
7	F	R		2	+			+	+
8	M	L	+	1	+		+	+	+
9	F	R		2	+	+	+	+	+
10	F	R		2	+		+	+	
11	M	R		1	+	+	+	+	
12	F	R		1	+				
13	F	L		1	+		+	+	
14	F	L		1	+		+	+	
15	F	L		3	+		+	+	
16	M	R		1	+	+	+	+	+
17	F	R		1	+	+	+		
18	F	L		1	+		+		+
19	M	L		1	+	+	+	+	
20	M	R		1	+		+	+	
21	F	L		1	+	+		+	
22	M	B		2	+	+	+	+	
23	M	R		3	+	+	+		+
24	F	R		2	+	+	+	+	+
25	M	L		1	+		+	+	
26	M	L	+	1	+		+	+	
27	F	L		2	+	+	+	+	+
28	F	L	+	1	+	+	+	+	
29	M	R		1	+		+	+	
30	F	L		3	+	+	+	+	+
31	M	L		1	+	+	+	+	
32	F	R		2	+	+	+	+	
33	F	R		1	+			+	

significant bony involvement with a blind or absent eye) (Figs 1, 2; Table 1).

Ptosis was a common finding in this cohort, with 28 (85%) patients undergoing ptosis surgery. The ptosis was usually secondary to diffuse infiltration of the levator with plexiform neurofibroma (Fig 3), but 3 patients (9%) had mechanical ptosis secondary to large nodular neurofibromas (Fig 4). Detachment of the lateral canthus was found to be present in 14 patients (42%). Six patients (18%) had significant brow infiltration, with secondary brow ptosis exacerbating the mechanical lid ptosis (case 2, Fig 5). Upper (Fig 6) and lower lid entropion and ectropion were usually secondary to complications from previous surgery. However, 1 patient with a primary lower lid mechanical ectropion was successfully treated by horizontal pentagonal lid resection (Figs 7, 8). Tear film problems were fairly common. One patient had a watering eye despite a lacrimal drainage system patent to syringing. This was thought to be due to floppy lids causing poor lacrimal pump function, which caused functional nasolacrimal duct obstruction (case 3, Fig 9). Three patients had dry eyes because of extensive conjunctival and lacrimal gland neurofibroma (Fig 10), infiltration, and previous debulking surgery.

Classification of Periorbital Deformities

We propose a new classification of periorbital deformities: (1) brow ptosis, (2) upper lid infiltration with ptosis, (3) lower lid infiltration, (4) lateral canthal disinsertion, and (5) conjunctival and lacrimal gland infiltration.

Complications from Previous Surgery and Their Treatment

Several patients had complications from previous lid surgery. Four patients (12%) still had complete ptosis, despite a history of multiple lid operations. All underwent further anterior levator resection and selective debulking surgery. Two patients had conjunctival prolapse develop (Fig 11) after anterior levator resection (secondary to disruption of the common sheath). This was successfully treated with further anterior levator resection and lid debulking. Corneal exposure after frontalis suspension occurred in 2 patients (Fig 6), who were managed by upper lid exploration and release of the bands of fascia lata. One patient had lower lid entropion with medial trichiasis develop after orbital debulking, which was treated with everting sutures. Another patient had an anophthalmic socket with volume deficit with excess lid bulk, a lower lid entropion, and a detached lateral canthus. He underwent an orbital implant exchange followed by an orbital floor implant. This was then followed by lid debulking, lateral canthal reattachment, and anterior levator resection.

Surgical Procedures

Anterior levator resection was undertaken in 28 patients (85%), often in conjunction with debulking of the neurofibroma. Fourteen patients (42%) underwent lateral canthal reattachment surgery. Two patients with blind eyes underwent enucleation during the course of follow-up. Other procedures included squint surgery to improve globe position.

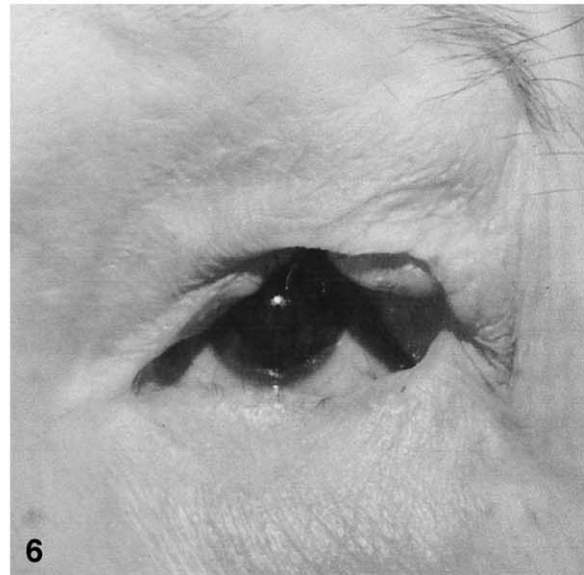
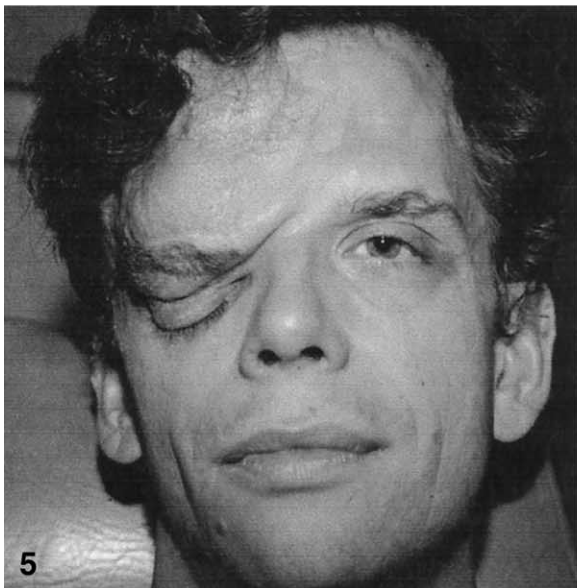
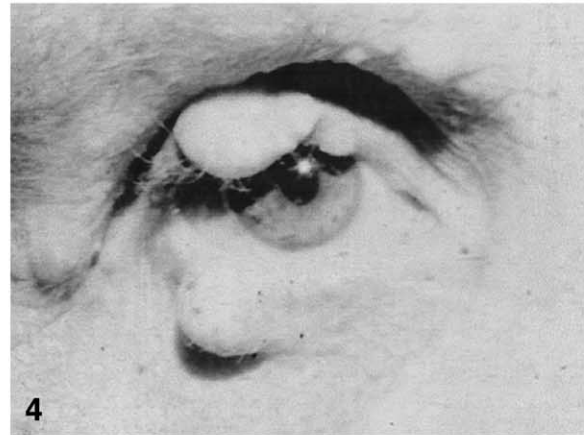


Figure 1. Patient with severe orbital neurofibromatosis infiltration with hypoglobus and a detached lateral canthus.
Figure 2. Patient after enucleation, neurofibromatosis debulking, and lateral canthal reattachment.
Figure 3. Ptosis secondary to plexiform neurofibromatosis infiltration of the upper lid, creating the classic S-shaped deformity.
Figure 4. Mechanical ptosis secondary to nodular neurofibroma.
Figure 5. Patient with severe brow infiltration causing brow ptosis, exacerbating his blepharoptosis (case 2).
Figure 6. Lid peaking, upper lid entropion, and corneal exposure after frontalis suspension with autogenous fascia lata.

Case 1

A 16-year-old female had severe left lid and orbital neurofibroma infiltration (Fig 12) causing hypoglobus and hypotropia, with a detached lateral canthus. Over the years, she underwent multiple

surgical procedures. The hypoglobus was treated with a Knapp procedure (raising the medial and lateral recti insertions) and an inferior rectus recession, but she subsequently underwent an enucleation and wore cosmetic prisms (Figs 13, 14). Her lower lid

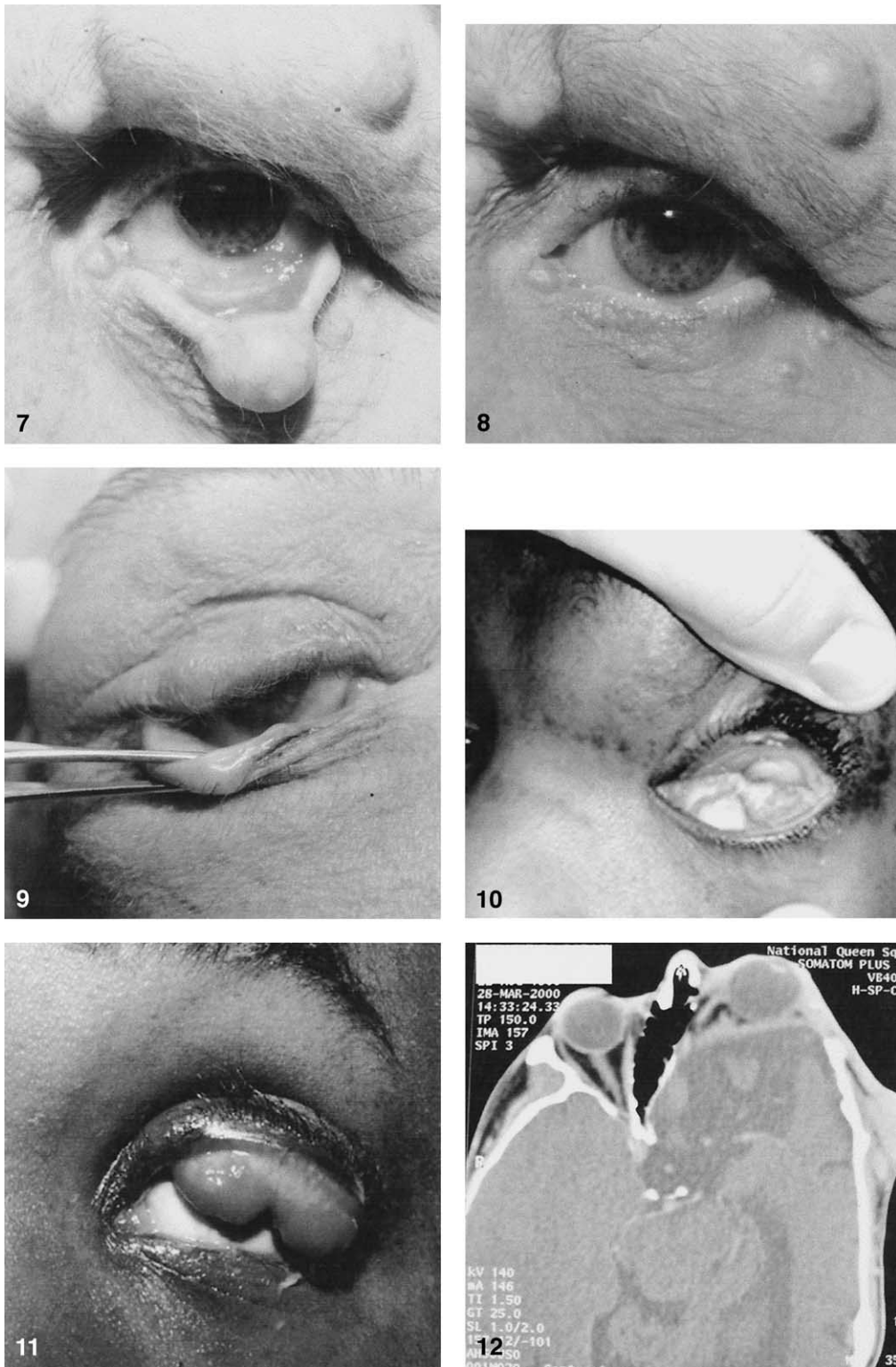


Figure 7. Mechanical lower lid ectropion secondary to nodular neurofibroma.

Figure 8. After pentagonal resection with resolution of mechanical ectropion.

Figure 9. Floppy eyelids causing poor lacrimal pump function and epiphora. Note that the lower punctum could be distracted past the pupillary plane (case 3).

Figure 10. Lacrimal gland and conjunctival neurofibromatosis infiltration in the presence of a blind buphthalmic eye with a mature white cataract.

Figure 11. Upper lid ectropion with conjunctival prolapse after anterior levator resection.

Figure 12. Computed tomography scan showing the classic skull deformities with absence of the greater wing of the sphenoid on the left, allowing the temporal lobe to prolapse through the enlarged superior orbital fissure (case 1).

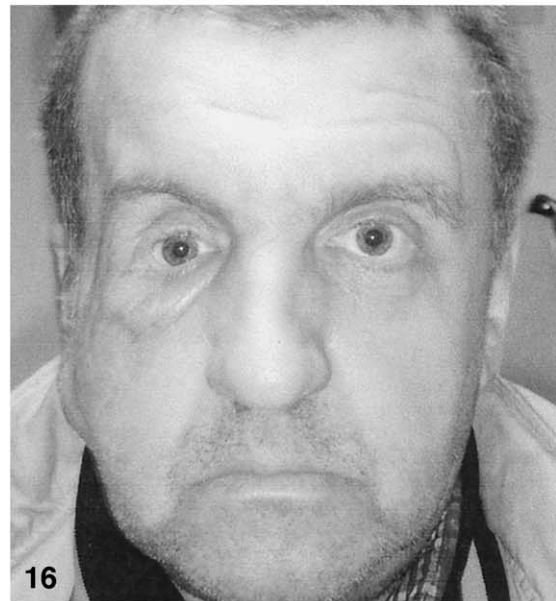
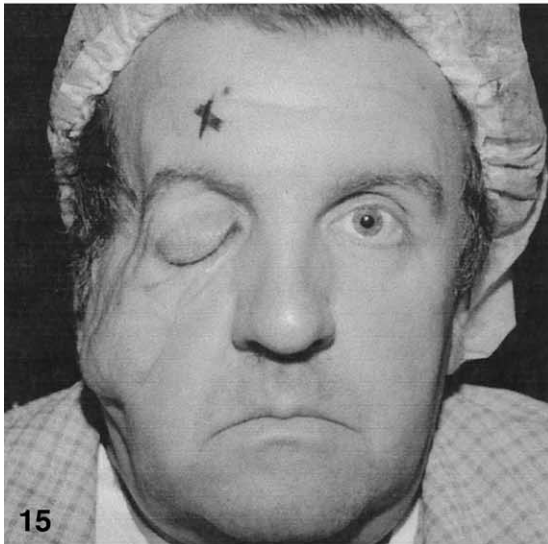
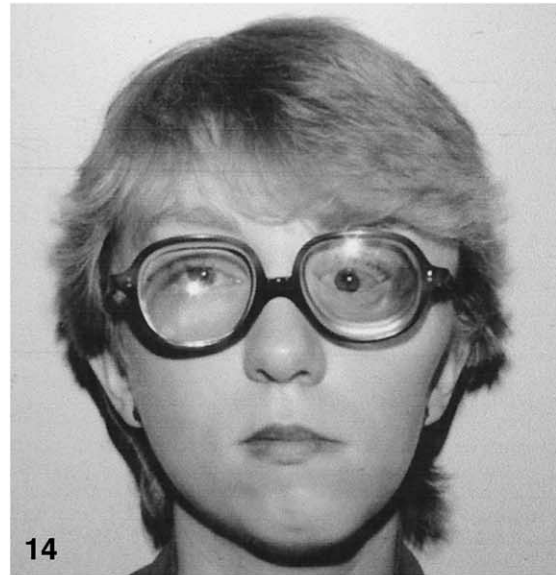


Figure 13. Case 1 with marked hypoglobus and proptosis without cosmetic prisms.
Figure 14. Case 1 with marked hypoglobus and proptosis with cosmetic prisms.
Figure 15. Case 4 preoperatively.
Figure 16. Case 4 postoperatively.
Figure 17. Case 5 at presentation.
Figure 18. Case 5 postoperatively.

laxity was treated initially by medial canthal repositioning, a lateral periosteal flap, and an upper lid bipedicle flap. After her enucleation, an autogenous fascia lata lower lid sling was inserted to stabilize her prosthetic eye. The neurofibromas were debulked, a lower lid pentagonal resection was undertaken, and the ptosis was treated with an anterior levator resection and lid debulking.

Case 2

A 31-year-old white male had a long history of mucopurulent discharge from his right phthisical eye. His right orbitotemporal neurofibromas had previously been debulked, but he still had extensive brow and lid neurofibromatosis (Fig 5). The lids were floppy, with secondary ectropion because of marked laxity of both limbs of the medial and lateral canthal tendons. The lids were shortened with full-thickness pentagonal resections, the forehead neurofibromas were debulked, and the brow tissues were sutured to the periosteum. Despite this, he had a persistently low medial brow and complete lid ptosis. He underwent further debulking procedures, including a medial brow lift and 2 anterior levator resections, before a good brow and lid position was achieved, and he was able to wear a cosmetic shell comfortably.

Case 3

A 42-year-old white female who had previously undergone neurofibroma excision complained of bilateral epiphora. She had neurofibromas affecting all 4 lids and bilateral severe lower lid laxity secondary to lax medial and lateral canthal tendons (Fig 9). After confirming lacrimal system patency, the epiphora was attributed to the floppy lids causing poor tear conductance through the lacrimal drainage system. The epiphora was partly relieved by shortening and attaching the medial and lateral canthal tendons to the orbital periosteum. It was further improved when she underwent bilateral dacryocystorhinostomies to decrease the resistance to tear drainage.

Case 4

A 43-year-old white male had extensive neurofibroma involving his right upper lid and cheek, a detached lateral canthus, and a complete ptosis with moderate (8 mm) levator function (Fig 15). One month after upper lid and conjunctival debulking, full-thickness lateral lid resection, levator advancement, and reattachment of the lateral canthus, he had severe discomfort from a postoperative upper lid ectropion with lateral conjunctival and tarsal prolapse. This gradually resolved with intensive tear supplements. The residual superior tarsal and cheek neurofibromas were debulked 1 year later, and the detached lateral canthus was reattached with a periosteal flap from the orbital rim. Postoperatively, he had a lateral upper lid entropion with a medial peak, which was relieved 4 months later by transposing the medial attachments of the levator complex laterally to raise the lateral part of the lid (Fig 16).

Case 5

A 58-year-old white male with left orbitotemporal NF underwent ptosis surgery at the age of 4 years and over the subsequent years underwent lateral canthal reattachment, neurofibroma debulking, a transposition skin flap from above the brow to below the lower lid, and a left upper lid blepharoplasty with conjunctival wedge resection. When first seen in our clinic, his left upper and lower lids were still extensively involved by plexiform neurofibroma, resulting in complete ptosis, lateral canthal tendon laxity, poor lid closure, and exposure keratopathy (Fig 17). The left upper and

lower lids were shortened with full-thickness pentagonal lid excisions, the lateral canthal tendon reattached, and the cheek neurofibroma debulked. Seven months later, the patient underwent maximal levator advancement with a Whitnall's sling, with further debulking of the neurofibroma, which achieved satisfactory appearance and comfort (Fig 18).

Discussion

Neurofibromas are one of the most common facial hamartomas.⁶ They consist mainly of Schwann cells, nerve fibers, and fibroblasts.⁷ Neurofibroma-infiltrated tissues are very vascular with wide-open capillaries that bleed copiously at surgery. Use of tumescent local anesthetic/adrenaline infiltration, hemostatic knives, and lasers can help to control hemostasis. The neurofibromas are not circumscribed or encapsulated and diffusely infiltrate tissues.⁸

The deformities of orbitotemporal NF have been described and classified by Jackson.⁴ In our series of 33 patients with orbitotemporal NF, common findings included unilateral and upper lid NF, ptosis, and detached lateral canthus. New findings, not previously documented, included severe brow infiltration, lacrimal gland involvement, and associated functional nasolacrimal duct obstruction. Complications from previous surgery included severe residual ptosis and poor lid contour, upper and lower lid entropion or ectropion, conjunctival prolapse, dry eye, and corneal exposure. There is a fundamental difference in the management of children and adults with orbitotemporal NF1. Rapid growth of neurofibromas typically occur in children and adolescents, and they should, therefore, remain under close observation in a specialized oculoplastic unit monitoring visual development to allow timely intervention with appropriate surgical procedures.^{9,10} Radical and definitive surgery is best delayed until the disease progression had slowed. In adults, a more aggressive surgical approach can be adopted to achieve a more permanent and definitive result. It is also easier to plan the time course of staged surgical procedures to correct the deformities over many months or years. Furthermore, many adult patients have complications from previous surgery that might require surgical intervention.

Conley¹¹ once stated "all results (of surgery in neurofibromatosis) are compromised by the very nature of the tumor, its diffuse position, its widespread involvement of all the constituents of a region or organ, and its tendency to recur." However, the surgical scars tended to be unobtrusive without a tendency to hypertrophy. In our series, using our classification of the periorbital pathology, the most common procedures performed in our series were (1) debulking of the neurofibromas of the brow, upper, and/or lower lids; (2) ptosis surgery (usually an anterior approach levator resection or occasionally frontalis suspension procedure with autogenous fascia lata); and (3) lateral canthal reattachment with a nonabsorbable suture, a periosteal flap, or an autogenous fascia lata lower lid sling.

We tailored any surgery to the patient's symptoms and the progression of the disease. In the treatment of upper lid plexiform neurofibromas, we do not recommend total "1-piece" lid removal (i.e., removal of all the infiltrated lid

tissue),¹² because the surrounding tissues are often involved and, instead, favor partial excisions to debulk the neurofibromas. The lateral part of the upper lid is typically more infiltrated (creating the classical S-shaped deformity), and a full-thickness pentagonal wedge can be excised in this area. Care must be taken to spare the lacrimal gland ductules when there is extensive conjunctival involvement. Pentagonal excisions can also be used to excise nodular neurofibromas causing mechanical ptosis in the upper lid or ectropion in the lower lid, often in conjunction with lateral canthal reattachment. In a blind eye, radical surgery, including enucleation, orbital debulking, or cosmetic prisms, can be considered. Ptosis surgery in patients with NF1 is challenging, and it is often difficult to judge the correct amount of levator resection because of the heavy infiltration. Despite this, all of our patients, even those with complete ptosis preoperatively, achieved a satisfactory elevation of the upper lid above the pupillary axis. This is in contrast to previous reports of poor outcome of ptosis surgery.¹³ In adults, when lateral canthal disinsertion has occurred, canthal reattachment can be achieved with a nonabsorbable suture (we use a 5-0 double-armed Prolene suture), but this might provide inadequate support for a prosthetic eye, and other methods such as a lateral periosteal flap¹⁴ or a lower lid fascial sling might be necessary. When a periosteal flap has been previously used, a burr hole needs to be drilled at the lateral orbital rim to allow attachment of the fascial sling. Although we do not recommend routine enucleation of all blind eyes, especially when a cosmetic shell could be worn for improved appearance, elective enucleation of a blind eye might be part of the debulking process, and usually no orbital implant insertion is required, because there is often increased orbital volume because of temporal lobe prolapse or neurofibroma infiltration. Significant hypoglobus can be partially corrected with a Knapp-type procedure, although in the presence of an enlarged orbit, this deformity will never be fully corrected.

To our knowledge, we have presented the largest series of adult patients with orbitotemporal NF with predominantly periorbital disease. We believe that surgical management of this condition differs significantly between adults and children. We favor a more aggressive surgical approach in adults, because there is slower disease progression, to achieve a more permanent and definitive result. All treatment needs to be tailored to the individual patient, who

should ideally be managed with close liaison between the craniofacial surgeon, neurosurgeon, plastic surgeon, oculo-plastic surgeon, and ophthalmologist. Through a series of staged surgical procedures, a substantial improvement in the cosmetic disfigurement of orbitotemporal NF can be achieved.

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