Intracranial Facial Nerve Grafting in the Setting of Skull Base Tumors: Global and Regional Facial Function Analysis and Possible Implications for Facial Reanimation Surgery

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Background: Reconstructive surgeons may encounter patients presenting after intracranial facial nerve resection and grafting in the setting of skull base tumors, who inquire regarding progression, final facial function, and need for future operations. Study goals were to analyze global and regional facial function using established grading systems and videography, while examine variables possibly affecting outcomes.

Methods: Between 1997 and 2012, 28 patients underwent intracranial nerve grafting. Fifteen were prospectively evaluated by three facial nerve physical therapists with the Facial Nerve Grading System 2.0 and the Sunnybrook Facial Grading Score for function and the Facial Disability Index for quality of life. Still photographs and videography were used to assess quality of motion and tone, while demographic and medical variables were analyzed regarding their effect on end results.

Results: Average patient age was 41.9 years (range, 22 to 66 years), and there were 10 women and five men. Average time interval between nerve grafting and evaluations was 42.9 months (range, 12 to 146 months). Both grading scores demonstrated best outcomes in the periorbita and worst outcomes in the brow. Buccinator muscle tone also improved. The average total Facial Disability Index was 67.5 percent. Although not statistically significant, the data suggest that nerve gap length affected total resting symmetry and voluntary movement, whereas preoperative palsy and age may affect total resting symmetry. Perioperative radiation therapy, tumor type, donor nerve, and coaptation technique were not found to affect outcomes.

Conclusions: Intracranial facial nerve grafting largely provides better resting tone and facial symmetry, potentially improving end results of future intervention; however, overall voluntary facial motion is poor. (*Plast. Reconstr. Surg.* 137: 267, 2016.)

CLINICAL QUESTION/LEVEL OF EVIDENCE: Therapeutic, IV.

Occasionally, patients present to the clinic with facial palsy after intracranial resection and grafting of the facial nerve in the setting of skull base tumors. The degree of palsy varies, but invariably these patients inquire as to the progression, final facial function, and the need for and timing of future operations. The primary study goals

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Received for publication May 27, 2015; accepted August 24, 2015.
Presented at the Best Paper Session at the American Society of Reconstructive Microsurgery Meeting, in Paradise Island, Bahamas, January 21 through 27, 2015; and at the 94th Annual Meeting of the American Association of Plastic Surgeons, in Scottsdale, Arizona, April 11 through 14, 2015.

DOI: 10.1097/PRS.0000000000001881

Disclosure: *The authors have no financial interest to declare in relation to the content of this article.*

Supplemental digital content is available for this article. Direct URL citations appear in the text; simply type the URL address into any Web browser to access this content. Clickable links to the material are provided in the HTML text of this article on the *Journal*'s Web site (www.PRSJournal.com).

were to analyze global and regional facial function after intracranial facial nerve grafting (Fig. 1) by means of established facial nerve grading systems and videography, and the secondary goals were to examine variables possibly affecting outcomes, improving patient consultation, setting expectations, and tailoring a treatment plan.

Over the past several decades, advances in skull base surgery and better understanding of the natural history and outcomes of patients undergoing operations directly or indirectly involving the intracranial facial nerve have enabled neuro-otologists and neurosurgeons to spare the facial nerve in most cases.[1–4] Still, in 1.5 to 2.5 percent of patients, facial nerve resection is necessary during tumor extirpation. Consequently, immediate direct tension-free nerve coaptation is optimal but frequently impossible, leaving interposition nerve grafting as the mainstay of treatment, provided that proximal and distal nerve segments remain.[5,6]

Several otolaryngology and neurosurgical studies evaluated the long-term facial function of patients after intracranial facial nerve grafting, but none provide detailed functional results by facial region, thus the nearly ubiquitous use of the House-Brackmann grading system, which is a common, reproducible, expedient, and easily communicable facial nerve grading system. Nevertheless, as Dr. House commented at the 12th International Facial Nerve Symposium in Boston, Massachusetts, in June of 2013[7] and as described in the original article by Drs. House and Brackmann, the House-Brackmann score was intended not for assessing facial palsy patients before and after reanimation but rather solely for evaluating facial nerve recovery after tumor extirpation.[8] Thus, no previous studies have discussed results in the setting of future reanimation procedures.

For more detailed global and regional facial function including synkinesis, several grading systems exist, aiding the surgeon in better understanding the anatomical and functional problem by facial region, possibly enabling a better-tailored solution. They also provide a better understanding of the facial areas more likely to recover, helping concomitantly to set patient expectations and possibly intervene earlier. Two such systems used in this study were the Facial Nerve Grading System 2.0[9] and the Sunnybrook Facial Grading Score.[10] As opposed to retrospective chart reviews of facial function provided by treating surgeons, a nonsurgical team graded patients prospectively to decrease bias. Furthermore, no previous studies assessed quality-of-life parameters after intracranial nerve grafting, important in consultation and future surgical planning, thus explaining the use of the Facial Disability Index.

Attempts to analyze variables possibly affecting outcomes such as age, radiation therapy, tumor

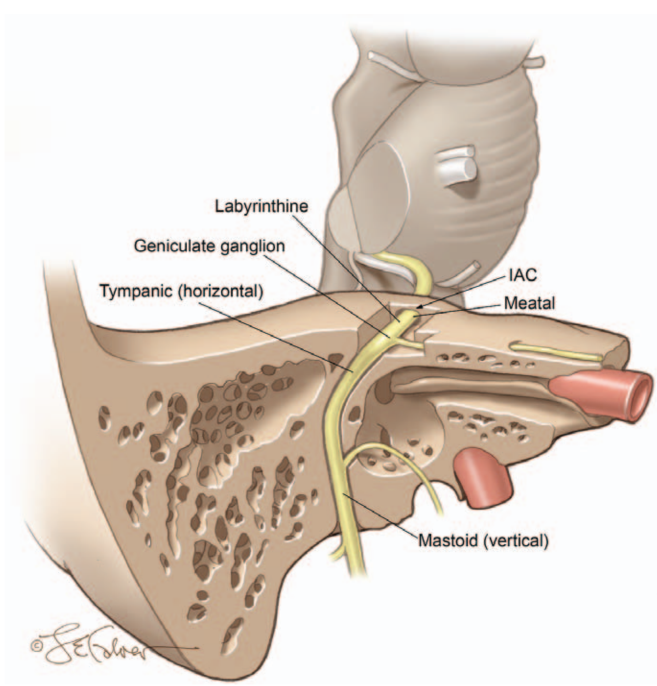


Fig. 1. Intracranial nerve grafting may include grafting to any portion of the nerve from the cisternal segment to the distal mastoid segment.

type, length or type of interposition graft, and nerve repair technique have been reported and reviewed here as well.[3,11–16] The literature is not uniform, but knowledge of these variables allows the surgeon to provide valuable prognostic information and anticipate future surgical intervention.

Detailed videography provided an added dimension but is lacking in the literature. Videography enables close evaluation of both dynamic and static changes over time, and reveals subtle changes less discernible by traditional grading systems (e.g., changes in buccinator muscle tonicity), as will be detailed later. (**See Video, Supplemental Digital Content 1**, which displays a 46-year-old man after acoustic neuroma resection and intracranial nerve grafting demonstrating improved facial motion after intracranial nerve grafting, 1, 3, 15, and 27 months after grafting, ***http://links.lww.com/PRS/B517***.) Thus, predicting both regional and global facial function after intracranial nerve grafting will enable surgeons to better guide patients during recovery and plan for possible future interventions.

PATIENTS AND METHODS

Institutional review board approval (STU-112012–019) was obtained. Between the years 1997 and 2012, 28 patients underwent intracranial nerve grafting during tumor extirpation. Two patients were ineligible, eight declined, and three could not be reached. Fifteen patients enrolled and completed evaluations. Patients who underwent intracranial facial nerve resection without grafting were excluded. All patients were prospectively evaluated by three physical therapists specializing in facial nerve rehabilitation and scored with two grading systems: the Facial Nerve Grading System 2.0 and the Sunnybrook Facial Grading Score. The Facial Disability Index was used for quality-of-life assessment. Furthermore, all patients underwent still photography and videography to assess quality of motion and tonicity in repose. Demographic and medical variables were analyzed as to their possible effect on end results. Nonparametric Spearman correlations and a relaxed value of $p < 0.15$ was used because of the smaller sample size. Because buccinator muscle tone and function seemed improved on videography, a questionnaire was devised to assess improvement over time with eating, namely, decreased buccal food accumulation.

Video 1. Supplemental Digital Content 1 displays a 46-year-old man after acoustic neuroma resection and intracranial nerve grafting demonstrating improved facial motion after intracranial nerve grafting, 1, 3, 15, and 27 months after grafting, ***http://links.lww.com/PRS/B517***.

RESULTS

The average age of the patients was 41.9 years (range, 22 to 66 years); 10 were women and five were men. The average time interval between nerve grafting to evaluations was 42.9 months (range, 12 to 146 months) (Table 1). The Facial Nerve Grading System 2.0 Total Movement Scale[1–6] demonstrated best outcomes in eye (2.3), intermediate results in oral commissure (4.33) and nasolabial

Table 1. Demographics

Characteristic	Value (%)
Total patients	15
Age, yr	
Average	41.9
Range	22–66
Female sex, %	67
Right side involved , %	60
Cause	
Acoustic neuroma	7 (46)
Facial nerve schwannoma	3 (20)
Parotid cancer (skull base invasion)	2 (13)
Hemangioma	1 (7)
Glomus jugulare tumor	1 (7)
GSW	1 (7)
Average preoperative House-Brackmann score	3.3
Interval from palsy to grafting, mo	
Average	14
Range	0–72
Time from grafting to PT assessment, mo	
Average	42.9
Range	12–146
Radiation therapy	
Preoperative	1 (7)
Postoperative	3 (21)
Donor nerve graft	
GAN	13
Sural	2
Type of coaptation	
Suture and glue	6
Glue	6
Suture	3
No. of strands in all cases	1

GSW, gunshot wound; PT, physical therapy; GAN, great auricular nerve.

Table 2. Facial Nerve Grading Score 2.0 Average for 15 Patients after Intracranial Nerve Grafting

Characteristic	Score
Brow (1–6)	5.8
Eye (1–6)	2.3
NLF (1–6)	4.7
Oral commissure (1–6)	4.3
Total movement	17
Synkinesis global assessment (0–3)	1.1
Final grade	4.3

NLF, nasolabial fold.

fold (4.7), and worse results in brow (5.8). The final Facial Nerve Grading System 2.0 grade average was 4.3 (scale, 1 to 5) (i.e., moderately severe dysfunction) (Table 2). The Sunnybrook Facial Grading Score revealed 64.3 percent to have oral resting symmetry but lesser resting symmetry in eye and nasolabial fold, 33.3 percent for both. Final average resting symmetry score was 10.3 (scale, 0 to 20). Symmetry in voluntary movement revealed the best function in gentle eye closure and lip pucker (4.0 and 3.1, respectively), whereas brow lift was worst at 1.1 and open mouth smile was 2.1. Final average voluntary movement score was 48.3 (scale, 20 to 100). Final average synkinesis score was low at 3.5 (scale, 0 to 15) (Table 3).

Average total Facial Disability Index was 67.5 percent, composed of the physical function and social/well-being portions averaging 65.0 percent and 70.4 percent, respectively. Physical function score subdivisions demonstrate eye

Table 3. Average Sunnybrook Facial Grading Score for Symmetry for 15 Patients after Intracranial Nerve Grafting

	Value (%)
Resting symmetry (0, normal; ½, asymmetric)	
Eye (0–1)	0.7 (33.3)
Cheek-NLF (0–2)	1.1 (33.3)
Mouth (0–1)	0.5 (64.3)
Total resting symmetry score (0–20)	10.3
Symmetry of voluntary movement (1–5)	
Brow lift	1.1
Gentle eye closure	4.0
Open mouth smile	2.1
Snarl	1.7
Lip pucker	3.1
Total	11.7
Total voluntary movement score (20–100)	48.3
Synkinesis (0, none; 1, mild; 2, moderate; and 3, severe)	
Brow lift	0.5
Gentle eye closure	0.9
Open mouth smile	0.6
Snarl	0.7
Lip pucker	0.9
Total synkinesis score (0–15)	3.5
Total composite score	32.4

NLF, nasolabial fold.

Table 4. Facial Disability Index Averages for 15 Patients after Intracranial Nerve Grafting

	Score
Physical function	
Difficulty eating	3.7
Difficulty drinking	3.9
Difficulty speaking	3.7
Eye tearing or dry	2.7
Difficulty brushing teeth	4.0
Subtotal physical	18.0
Calculated total	65.0%
Social/well-being	
Time felt calm and peaceful	4.1
Isolated from people	4.5
Irritable toward others	4.6
Waking early/frequently	4.0
Time preventing social activities	5.3
Subtotal social	22.6
Calculated total	70.4%
Total Facial Disability Index	67.5%

dryness/tearing as worst, and brushing teeth, eating, drinking, and difficulty speaking as best outcomes (Table 4).

Video analysis confirms the grading score findings, also demonstrating improved buccinator muscle function and tone, a muscle not assessed in the grading scores used in this study. A questionnaire assessing buccinator muscle function demonstrated a decrease in buccal food accumulation over time. Thirty-three percent of patients (five of 15) noted great improvement, 47 percent (seven of 15) noted moderate improvement, and 20.0 percent (three of 15) had little to no improvement, with a mean follow-up of 50 months (Table 5).

Preoperative, intraoperative, and postoperative variables possibly affecting postoperative facial function were analyzed. Because of the smaller sample size, we used the nonparametric Spearman correlations and a relaxed value of $p < 0.15$. Although not statistically significant, the data suggested that nerve gap length affected both total resting symmetry ($r = 0.437$, $p = 0.103$) and total voluntary movement ($r = 0.395$, $p = 0.145$) and that preoperative palsy and age may also affect total resting symmetry ($r = 0.506$, $p = 0.055$; $r = 0.394$, $p = 0.146$, respectively). Perioperative radiation therapy, tumor type, donor nerve, and coaptation technique were not found to affect outcomes.

DISCUSSION

Facial palsy patients arrive with a wide range of clinical presentations varying in causes, degrees of recovery, and duration from the onset of facial palsy. Patients after facial nerve resection without reconstruction or with facial nerve continuity

Table 5. Buccal Muscle Function Averages for 15 Patients after Intracranial Nerve Grafting

Questionnaire				
We are contacting you again in order to obtain more specific information regarding the buccinator muscle function; this is the muscle that forms the wall of the cheek. There are no right or wrong answers for these questions.				
Immediately after your surgery, did you notice food getting trapped, on the paralyzed side of the face, between your cheek and your teeth?	If so, has this improved over time after grafting?	Do you find that less food gets stuck between the inside of your cheek and the teeth now compared to the immediate period following surgery?	How much improvement have you noticed? Options: none, little, moderate, or great improvement	Comments
Results				
No. of patients	Great improvement in buccal food accumulation	Moderate improvement in buccal food accumulation	Little to no improvement in buccal food accumulation	
15	5 (33%)	7 (47%)	3 (20%)	

presenting after 2 years of facial palsy are similar in that they will not improve without intervention. The more challenging group is patients in the acute or intermediate period with nerve continuity, whether preserved or reconstructed, not having reached a functional plateau with potential to improve.

One such group is patients after intracranial tumor and facial nerve resection who undergo reconstruction by immediate nerve grafting. Some of these patients suffer from differing degrees of palsy before tumor resection and nerve grafting, often because of delayed referral patterns to a tertiary skull base program, misdiagnosis, or previous skull base surgery resulting in partial palsy, whereas others present with variable degrees of palsy after grafting at different time intervals, likely culminating in different end results (Figs. 2 through 5), posing a treatment dilemma for both surgeon and patient, invariably raising several key questions:

1. What is the expected end point of recovery?
2. Will facial areas recover differentially?
3. When is further recovery not expected?
4. Do preoperative, intraoperative, or postoperative variables affect final outcomes?
5. Are interim procedures indicated before reaching a recovery plateau?
6. What procedures are likely needed once that plateau is reached?

For the surgeon performing facial reanimation, evidence-based global and regional functional facial outcomes, including resting tone, voluntary movement, and synkinesis, are important in strategizing a treatment plan.

Long-Term Outcomes of Intracranial Facial Nerve Grafting: Global and Regional Function Analysis

Global Function Analysis

Several studies discuss the long-term outcomes of patients who underwent intracranial facial nerve grafting. These studies are summarized in Table 6.[3,5,13,16–25]

This study has several similarities and dissimilarities with regard to the aforementioned studies. All previous studies were performed as retrospective chart reviews, with results provided by the surgeons, failing to note who and how assessments were performed. In this study, independent facial nerve physical therapists using two facial nerve grading scores and a facial disability score evaluated all patients as part of a prospectively planned study. This may explain the discrepancy between our results and previous studies, which perhaps erred on giving patients better functional outcomes. In these latter, the authors, mostly neuro-otologists who performed the operations, graded the majority of the patients as House-Brackmann grade III. In the original article of Drs. House and Brackmann, a score of 3 is described as having slight to moderate movement in the forehead, whereas 4 has none. Although very slight forehead movement is possible after intracranial nerve grafting, we would argue that it is rare. Therefore, most aforementioned studies should likely have had a higher percentage of House-Brackmann grade IV (i.e., moderately severe dysfunction), conforming more to our results with the Facial Nerve Grading System 2.0 score of 4.3.

Synkinesis analysis in previous studies is lacking detail because the House-Brackmann score inherently does not detail this aspect. Although synkinesis is a potential pitfall of proximal grafting, most patients tend not to develop severe synkinesis, obtaining a low score on both grading systems, with a Facial Nerve Grading System 2.0 score of 1.3 (range, 0 to 3) and an average Sunnybrook Facial Grading Score total score of 3.8 (range, 0 to 15). In other words, although good voluntary facial motion is not achieved in most patients, a fair balance between minimal synkinesis and good resting tone is observed.

Fig. 2. A 42-year-old woman with history of neurofibromatosis and resection of acoustic neuroma 32 months after intracranial seventh cranial nerve grafting shown (*left*) in repose and (*right*) while smiling.

Regional Function Analysis

Forehead

Resting tone. The average Facial Nerve Grading System 2.0 grade for the forehead was 5.8—nearly complete palsy—whereas the Sunnybrook Facial Grading Score grading does not address resting forehead tone (Table 2).

Voluntary movement. Based on both the Facial Nerve Grading System 2.0 score and Sunnybrook Facial Grading Score (5.8 and 1.1, respectively), no motion is noted in the forehead.

Synkinesis. Brow synkinesis is very low at 0.6 (scale, 0 to 3).

Periorbita

Resting tone. The best average resting tone observed was the periorbital region (Tables 2 and 3). This was congruent in both grading systems: highest in the Facial Nerve Grading System 2.0 (2.3) and second in the Sunnybrook Facial Grading Score (0.7) (mouth, 0.5) (Fig. 3). Periocular tone is mainly important in the lower eyelid position versus the upper eyelid, where initiation of motion and blink reflex are key.

Voluntary movement. Most patients demonstrate initiation of voluntary motion (Facial Nerve Grading System 2.0 score, 2.3; Sunnybrook Facial Grading Score, 4.0), obtaining a partial blink reflex.

Synkinesis. Although the highest of the facial regions, average synkinesis was low at 0.9.

Midface

Resting tone. The average midface resting symmetry (nasolabial fold) according to the Facial Nerve Grading System 2.0 score and Sunnybrook Facial Grading Score was 4.7 and 1.1, respectively; the latter demonstrated the presence of a nasolabial fold, with relatively good symmetry in repose but more limited ability to smile (Fig. 4).

Voluntary movement. Overall midface function (both zygomaticus and levator muscles of the lip) is poor. Facial Nerve Grading System 2.0 score for oral commissure was 4.7 and Sunnybrook Facial Grading Score for open mouth smile was 2.1 (Tables 2 and 3). The midface symmetry mostly improves from its initial flaccid state, but the ability to smile is poor.

Synkinesis. Midface or open mouth synkinesis is low at 0.6.

Oral

Resting tone. Oral and philtral symmetry in repose is likely more dependent on orbicularis oris muscle tone than zygomaticus muscle or lip levator muscle tone, especially seen as the increased distance from the modiolus to the ipsilateral philtral column on the paralyzed side (Fig. 5). The average Facial Nerve Grading System 2.0 grade for the oral region was 4.3, second only to the eye, but does not differentiate well between resting tone and motion. The Sunnybrook Facial Grading Score offers better insight into the oral

Table 6. Summary of Additional Studies on Facial Nerve Function after Intracranial Nerve Grafting

First Author, Year	No. of Patients	Mean Follow-Up	Duration of Palsy (mo)	Results			
				HB III	HB IV	HB V	HB VI
Ramos, 2015[3]	15	18 mo	11.3	87	13	—	—
Ozmen, 2011[13]	155	41.7 mo	25.4	68	15	5	12
Gunther, 2010[17]	21	10.3 yr	5.4	86	9	5	—
Bacciu, 2009[16]	33	>1 yr	NS	76	18	3	3
Malik, 2005[18]	25	NS	NS	56	54	—	—
Falcioni, 2003[19]	56	>1 yr	20.2	46	25	13	16
Bascom, 2000[7]	61	>1 yr	13	61	21	10	8
Gidley, 1999[21]*	25	20 mo	3.4	8 (B)	54 (C)	15 (D) 8 (E)	15 (F)
Magliulo, 1998[22]	6	22.3 mo	16.1	67		33	
King, 1993[23]	12	5.3 yr	NS	41	17	25	17
Stephanian, 1992[24]	24	20 mo	NS	45	36		18
Arriaga, 1992[5]	8	32.5 mo	7.4	13	37	25	25
Yammine, 1999[25]	4	31.6 mo	NS	50	50	—	—

HB, House-Brackmann; NS, not specified.
*Used Facial Nerve Recovery Scale for results.

region, emphasizing all portions of the orbicularis oris muscle, with an average grade of 0.5, the most improved tone among facial regions. Photographs and videos clearly demonstrate that patients who are able to purse their lips have better oral tone and symmetry.

Voluntary movement. The Facial Nerve Grading System 2.0 does not differentiate oral function well, but the Sunnybrook Facial Grading Score for lip pucker is high at 3.2. This is notable on patient photographs and videos, likely contributing to higher eating, drinking, and brushing teeth scores in the Facial Disability Index scale, with improved oral/lip competency over time decreasing fluid drooling.

Synkinesis. Although highest, equal to the periorbital region, it is overall low at 0.9.

Buccinator

Resting tone. Patients with flaccid facial palsy lack buccal contracture because of buccinator muscle paralysis, resulting in food accumulation in the buccal region. Based on the Facial Disability Index scores, eating was not reported as a major hindrance, averaging 3.8. However, in a previous study, when patients were asked about eating after dynamic reanimation, 90 percent reported improvement mainly in lack of drooling, but stated that the most dominant remaining

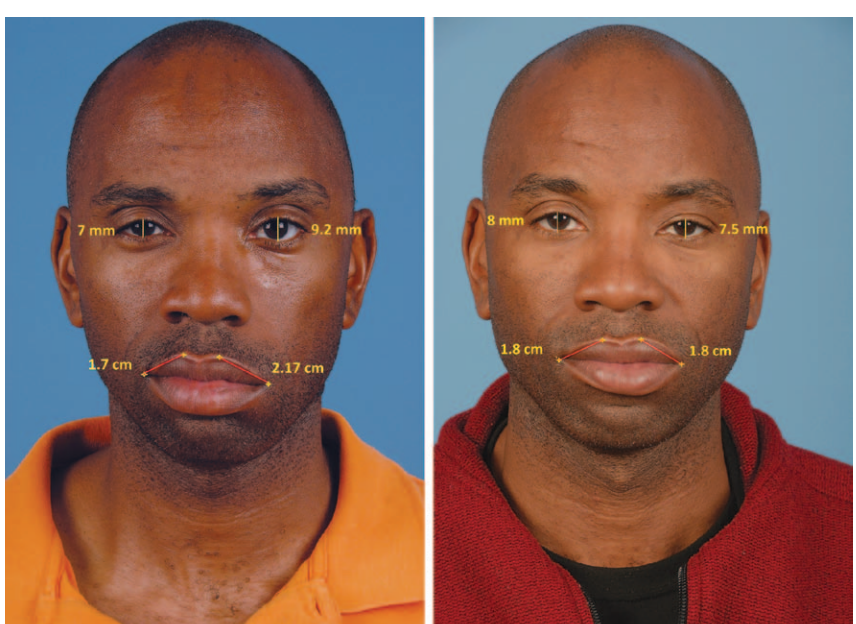


Fig. 3. A 46-year-old man after acoustic neuroma resection and intracranial nerve grafting, (*left*) 1 month after grafting and (*right*) 27 months after grafting, demonstrating improved periorbital and oral tone

Fig. 4. Demonstration of good midface symmetry in repose but poor voluntary motion. (*Above*) A 27-year-old patient, 73 months after resection of a glomus jugulare tumor with CyberKnife (Accuray, Sunnyvale, Calif.) radiation therapy after facial nerve resection and intracranial seventh cranial nerve reconstruction with sural nerve graft shown in repose and while smiling. (*Below*) A 46-year-old woman, following acoustic neuroma resection 13 years after intracranial nerve grafting shown in repose and while smiling.

problem was buccal accumulation of food.[26] Because even the Facial Disability Index score is not specific for the buccinator muscle function, we created a questionnaire specifically asking whether food accumulation in the buccal region improves over time. Patients reported significant improvement (Table 5). In addition, videos and still photographs clearly revealed the increased tonicity of this region. (**See Video, Supplemental Digital Content 2**, which shows a 46-year-old man after acoustic neuroma resection and intracranial nerve grafting demonstrating improved buccinator muscle function over time. Note the decrease in buccal laxity when attempting to whistle 1, 3,

Fig. 5. A 28-year-old man after resection of facial schwannoma and intracranial seventh cranial nerve grafting, showing changes over time in the modiolus to philtral column distance, (*left*) 8 months and (*right*) 25 months after grafting.

15, 27 months postoperatively, ***http://links.lww.com/PRS/B518***.)

Lip Depressors

Depressor function. The Facial Nerve Grading System 2.0 and Sunnybrook Facial Grading Score instruments do not assess lower lip depressor function. Based on video analysis, lower lip depressors show minimal functional recovery in all patients.

Video 2. Supplement Digital Content 2 shows a 46-year-old man after acoustic neuroma resection and intracranial nerve grafting demonstrating improved buccinator muscle function over time. Note the decrease in buccal laxity when attempting to whistle 1, 3, 15, 27 months postoperatively, ***http://links.lww.com/PRS/B518***.

Variables Affecting Long-Term Outcomes of Intracranial Facial Nerve Grafting

Select studies discuss which factors most affect outcomes, but no clear consensus exists.[3,5,12,13,16,24,27–29] For a summary of previous studies, see Table 7. Because of the smaller sample size, we used the nonparametric Spearman correlations and a relaxed $p < 0.15$. Although not statistically significant, the data suggested that nerve gap length affected both total resting symmetry ($r = 0.437$, $p = 0.103$) and total voluntary movement ($r = 0.395$, $p = 0.145$). In addition, time from palsy to surgery and age may also affect total resting symmetry ($r = 0.506$, $p = 0.055$; and $r = 0.394$, $p = 0.146$, respectively). Perioperative radiation therapy, tumor type, donor nerve, or coaptation technique was not found to affect outcomes.

Possible Implications of Intracranial Nerve Grafting on Facial Reanimation Procedures

The main goal of this study was to provide objective data as to the regional and global facial nerve function after intracranial nerve grafting but possibly also provide the ground for discussion on implications in facial reanimation. Because overall results are variable and regional facial recovery differential, timing on intervention is a key component. Although many patients achieve good midface symmetry in repose and some improved periocular, perioral, and buccal tone, voluntary motion is limited. (**See Video, Supplemental Digital**

Table 7. Summary of Additional Studies on Possible Variables Affecting Long-Term Facial Nerve Outcomes after Intracranial Facial Nerve Grafting

First Author, Year	Preoperative Facial Nerve Grade	Preoperative Deficit Duration	Length of Graft	Age	Technique of Anastomosis
Ozmen, 2011[13]	NS	*	NS	NS	NS
Bacciu, 2009[16]					NS
Malik, 2005[18]	NS			*	
Falcioni, 2003[19]		*			
Bascom, 2000[20]		*			
Gidley, 1999[21]	NS		NS		
Stephanian, 1992[24]	*		NS		
Arriaga, 1992[5]	*				NS

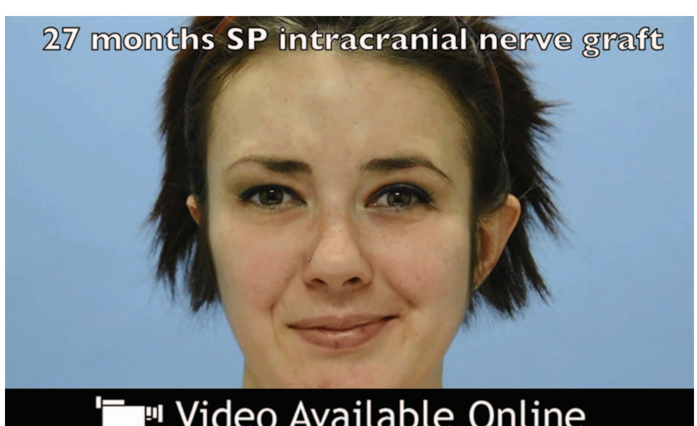
NS, nonsignificant.
*Significant.

Content 3, which displays a 27-year-old 73 months after resection of glomus jugulare tumor with CyberKnife radiation therapy after facial nerve resection and intracranial seventh cranial nerve reconstruction with sural nerve graft. Resting symmetry is good but voluntary motion is poor, ***http://links.lww.com/PRS/B519***. **See Video, Supplemental Digital Content 4**, which displays a 46-year-old woman following acoustic neuroma resection 13 years after intracranial nerve grafting. Resting symmetry is good but voluntary motion is poor, ***http://links.lww.com/PRS/B520***.)

Therefore, early intervention, as suggested by several previous studies, is further supported by these data. Full discussion of treatment is beyond the scope of this text, but for the interested reader we recommend reviewing several studies on the principles of the "baby-sitter" procedure, emphasizing the importance of early intervention to maximize results.[30–33] These studies involve patients with facial palsy of various causes and clinical scenarios, but principles of early treatment are relevant to our patient study group as well. Because in this group grafting procedures are performed in the intratemporal portion of the facial nerve, we prefer to babysit select branches of the midface for smile and periorbita, rather than cutting the facial nerve trunk as described originally, in addition to early cross-facial nerve grafting, thus preserving the benefit of intracranial grafting, providing tone and symmetry as demonstrated here. In cases when the baby-sitting procedure fails to provide sufficient powering of the smile and a free muscle transfer is used, we mostly combine the cross-facial nerve graft intended for smile and a nonfacial donor to power the muscle. These approaches are for more in-depth discussions in future studies or studies by others as mentioned above.[31,34–36]

Quality of Life after Intracranial Facial Nerve Grafting

Finally, no previous studies discuss the quality of life after facial nerve grafting after intracranial nerve resection. When analyzing the Facial



Video 3. Supplement Digital Content 3 displays a 27-year-old 73 months after resection of glomus jugulare tumor with CyberKnife radiation therapy after facial nerve resection and intracranial seventh cranial nerve reconstruction with sural nerve graft. Resting symmetry is good but voluntary motion is poor, ***http://links.lww.com/PRS/B519***.

Video 4. Supplement Digital Content 4 displays a 46-year-old woman following acoustic neuroma resection 13 years after intracranial nerve grafting. Resting symmetry is good but voluntary motion is poor, ***http://links.lww.com/PRS/B520***.

Disability Index, on the physical function portion, the worst aspect is dry eyes/tearing, with an average score of 2.6, but otherwise patients fare well in the eating, speaking, and mouth-rinsing portions. On the social/well-being portion of the index, the worst outcomes include percentage time calm/peaceful and frequency of waking up during nighttime sleep, with an average score of 4.2. Synkinesis has not been found to be severe in this group of patients, and from a quality-of-life perspective on both functional and social well-being scores, patients fair relatively well. This information has value during consultation with patients, predicting and preparing patients as to what is likely to be construed as a future problem versus issues that will play a less significant future concern. Although the periorbita is the area most likely to improve, and early intervention with a baby-sitter procedure may bring further improvement, the lacrimal function will likely never recover secondary to irreversible parasympathetic disruption. Clarification that some degree of lubrication will always be needed is warranted, and that in rare cases of excess tearing, tear ductal surgery is available but mostly unnecessary. Conversely, a patient may be comforted that eating and speaking will improve over time and synkinesis will unlikely become prohibitive.

CONCLUSIONS

Intracranial facial nerve grafting is indicated, if feasible, when facial nerve resection is unavoidable during tumor extirpation to avoid complete flaccid facial paralysis. With grafting, better resting tone and facial symmetry are mostly observed and select facial areas recover better (i.e., the periorbital, oral, and buccal regions), improving results regardless of future intervention, yet overall voluntary facial motion is poor. We hope this evidence-based global and regional facial analysis and previous studies on early intervention will provide a basis for early communication among neuro-otologists, neurosurgeons, and plastic and reconstructive surgeons, enabling early assessment and intervention, significantly improving results in this population.

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ACKNOWLEDGMENT

This work was funded by the David M Crowley Foundation.

PATIENT CONSENT

Patients provided written consent for the use of their images.

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