

Comparative Outcomes Of Motor Nerve To The Masseter and Cross-Facial Nerve Grafting In Pediatric Free Gracilis Muscle Transfer: A Machine Learning Analysis Of Smile Symmetry

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Introduction

- Facial nerve palsy (FNP) in the pediatric population leads to significant functional impairment and facial asymmetry. Free gracilis muscle transfer (FGMT) is the cornerstone technique for dynamic smile reanimation.
- The optimal donor nerve remains debated: cross-facial nerve grafting (CFNG) is typically used when spontaneous smile is prioritized, while motor nerve to the masseter (MNM) is favored for faster rehabilitation and greater excursion. To date, limited objective, longitudinal data exist comparing outcomes between these techniques.

Objective

To objectively compare facial symmetry and longitudinal recovery trajectories following pediatric FGMT using MNM versus CFNG, employing machine learning-based image analysis.

Methods

Retrospective review of pediatric FGMT patients (2007–2020): Standardized photographs at repose, smile, and open smile were analyzed via following symmetry deviations: commissure excursion, smile angle, commissure height, upper lip height, and lower lip height. Outcomes were evaluated at pre-op and postoperative years 1, 2, and 3 using mixed-effects modeling.



Repose



Smile



Open Smile

Commissure excursion dev	Technique (reference: CFNG)		Year (reference: pre-op)		Interaction	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Smile	-0.148	0.004	Y1: -0.003	0.948	Y1: -0.133	0.025
			Y2: -0.030	0.575	Y2: 0.177	0.013
			Y3: 0.009	0.835	Y3: -0.147	0.051
Open Smile	-0.051	0.482	Y1: -0.184	0.000	Y1: -0.015	0.885
			Y2: -0.105	0.036	Y2: -0.100	0.418
			Y3: -0.100	0.077	Y3: -0.115	0.288

Commissure height dev	Technique (reference: CFNG)		Year (reference: pre-op)		Interaction	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Smile	-1.837	0.382	Y1: -2.617	0.153	Y1: 0.427	0.858
			Y2: -1.252	0.556	Y2: -2.562	0.361
			Y3: -2.803	0.126	Y3: -0.937	0.756
Open Smile	-4.206	0.026	Y1: -1.519	0.110	Y1: -5.356	0.012
			Y2: -1.787	0.087	Y2: -3.414	0.196
			Y3: -0.870	0.471	Y3: -6.600	0.006

Upper lip height dev	Technique (reference: CFNG)		Year (reference: pre-op)		Interaction	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Smile	-1.260	0.341	Y1: -2.408	0.024	Y1: 0.433	0.751
			Y2: -2.012	0.093	Y2: -0.640	0.684
			Y3: -1.783	0.095	Y3: -1.713	0.319
Open Smile	-3.281	0.048	Y1: -1.340	0.057	Y1: -6.730	0.000
			Y2: -1.736	0.026	Y2: -5.763	0.004
			Y3: -1.879	0.038	Y3: -4.528	0.016

Results

Demographics: 12 patients, mean age 12.2 ± 4.7 years. Most common etiology: hemifacial microsomia (41.7%). Donor nerve: obturator (100%); recipient nerve: facial/CFNG (66.7%), trigeminal/MNM (33.3%).

Commissure Excursion: MNM demonstrated significantly improved symmetry during smile (p=0.004), with significant technique-by-time interactions at Y1 (p=0.025) and Y2 (p=0.013). During open smile, symmetry improved over time regardless of technique.

Commissure Height: MNM showed a significant overall advantage during open smile (p=0.026), with technique-by-time interactions at Y1 (p=0.012) and Y3 (p=0.006).

Upper Lip Height: MNM demonstrated a significant overall advantage during open smile (p=0.048), with significant interactions at all postoperative years (Y1 p<0.001, Y2 p=0.004, Y3 p=0.016).

Smile Angle & Lower Lip Height: No significant overall technique effects. However, smile angle showed significant MNM-favoring interactions during open smile at Y1 (p=0.033) and Y3 (p=0.005). No significant differences in lower lip height deviation or at rest across all metrics.

Conclusions

- MNM demonstrated both overall and time-dependent advantages over CFNG in restoring facial symmetry following pediatric FGMT.
- MNM was associated with improved commissure excursion (smile), commissure height (open smile), and upper lip height symmetry (open smile) compared to CFNG.
- Longitudinal assessment reveals recovery trajectory differences between donor nerves not captured by single time-point analysis.