



Long-term Outcomes Comparing Between Single Versus Dual Innervated Free Functional Gracilis Muscle Transfer In Longstanding Facial Paralysis Patients

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Introduction

For longstanding facial paralysis, a free functional muscle transfer (FFMT) is the most common treatment strategy.¹⁻³ Over the last decade, dual innervation of a FFMT using a combination of a cross-facial nerve graft (CFNG) and the nerve-to-masseter (NTM) has become more common in an attempt to provide the advantages of both donor nerve characteristics – strength from the NTM combined with tone, synchronicity, and spontaneity from the facial nerve.⁴⁻⁸ Long-term evidence to the effects of dual innervation on tone and excursion is lacking as well as direct objective comparison to NTM-innervated FFMT (single innervation). The goal of this study was to assess whether the addition of a CFNG to a NTM innervating a free functional muscle transfer provides any objective long-term benefits in tone and excursion at rest, closed, and open smile in patients with long-term results ranging between 1 and 3 years.

Methods

Facial palsy patients receiving an FFMT with single innervation using NTM alone and dual innervation using NTM+CFNG by the senior author from 2013-2022 were reviewed. Inclusion criteria required a minimum of 2 postoperative photographic documentation, as well as a minimum of one year of follow up. We obtained objective facial measurements including commissure excursion, commissure position at rest, smile angle, commissure height deviation, and upper lip height deviation using Emotrics and measured dental show using ImageJ from photos organized into time-based cohorts with an average of 3 months, 1 year, and 3 years of follow up as available. Statistical methods included Wilcoxon Signed Rank Tests to assess significant differences from preoperative facial measurements at each time point as well as between treatment groups.

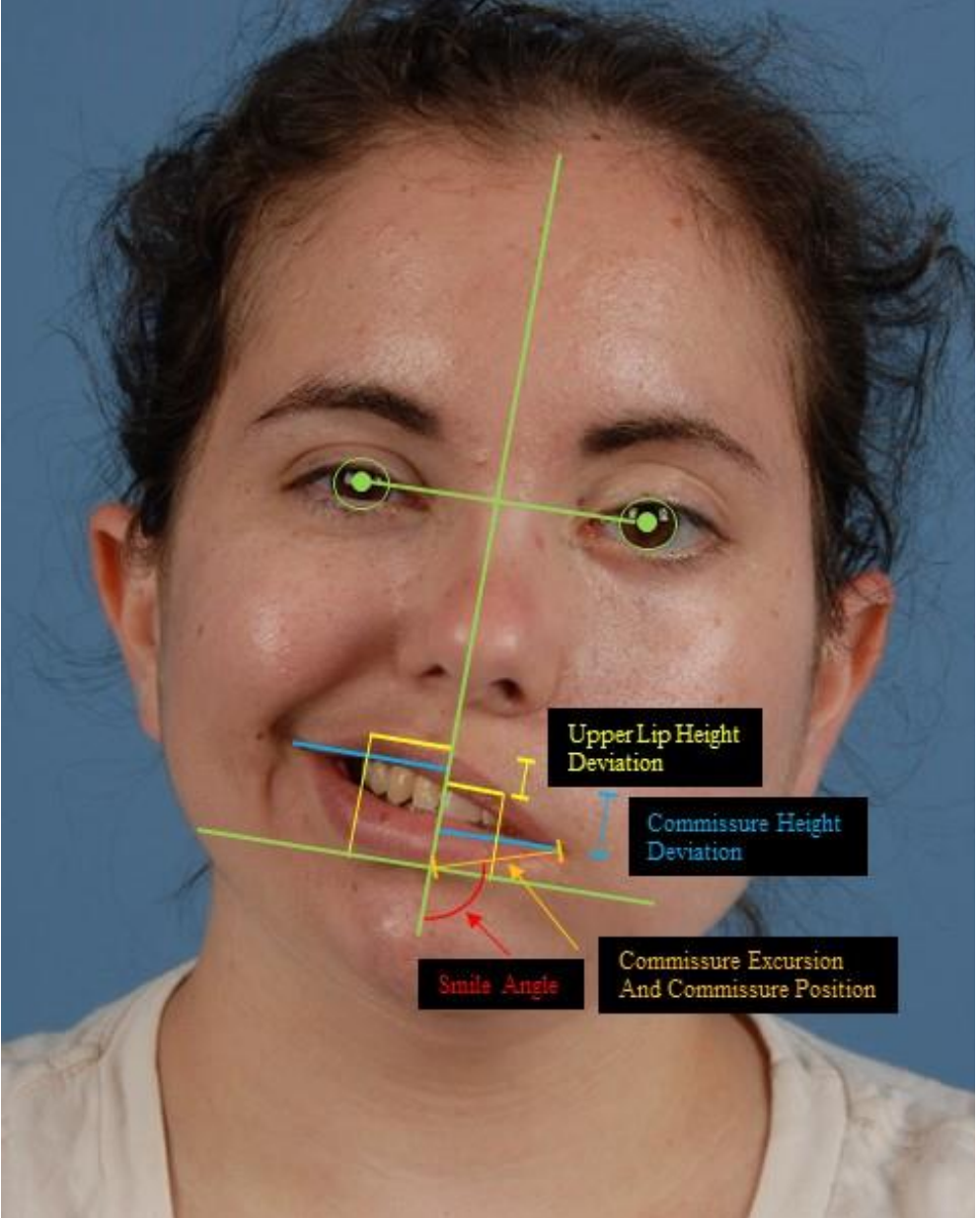


Figure 1: Left: Emotrics measurements including Commissure Excursion and Commissure Position (orange), Smile Angle (red), Commissure Height Deviation (blue), and Upper Lip Height Deviation (yellow). Right: ImageJ measurements of teeth exposure area with quadrants.



Results

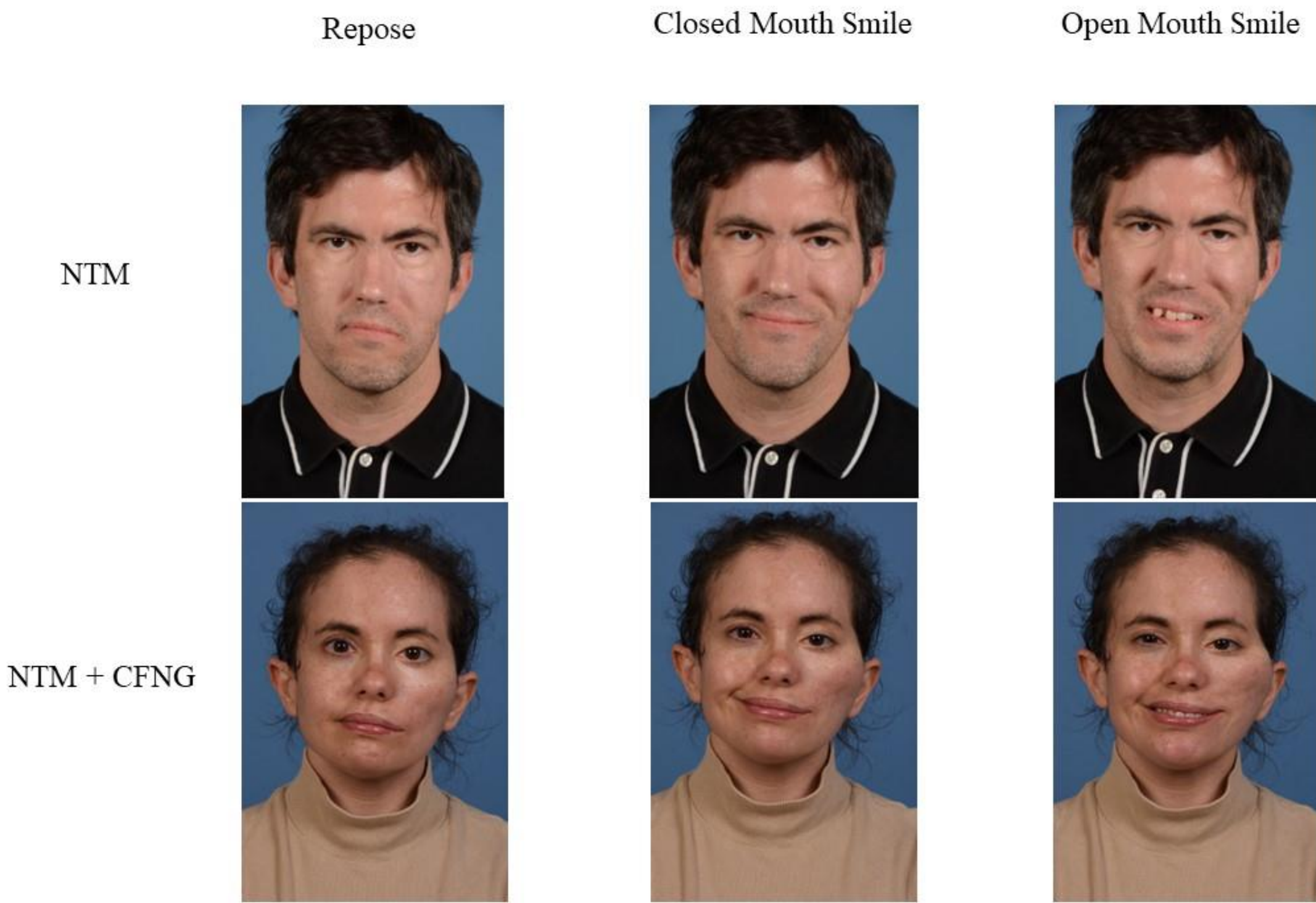


Figure 2: 3-year postoperative images. Figure 2a (top row) depicts a 38-year-old male who presented with left-sided congenital facial palsy (Moebius Syndrome) and underwent single-innervated FFMT using an NTM. Figure 2b (bottom row) depicts a 23-year-old female who presented with left-sided facial palsy after a schwannoma resection done 11 years prior. She underwent 2-stage, dual-innervated FFMT using an NTM+CFNG.

Single versus dual innervation comparison - commissure position and commissure excursion on the palsy side

Commissure Excursion	Single Innervation Group		Dual Innervation Group		Difference between Groups	
	Median	IQR	Median	IQR		P Value
Repose	(mm)	(mm)	(mm)	(mm)	(mm)	
Pre op	23.11	5.69	22.23	5.94	0.88	NS
Post op (0-6 months)	27.065	3.52	25.065	5.29	2	NS
1 Year	28.195	3.65	25.95	5.14	2.245	NS
3 Years	26.42	3.63	31.51	4.55	5.09	<0.001
Closed Mouth Smile						
Pre op	22.705	8.77	22.66	3.79	0.045	NS
Post op (0-6 months)	28.815	7.19	26.515	4.98	2.3	NS
1 Year	30.775	4.815	28.05	6.31	2.725	NS
3 Years	29.145	5.99	29.7	3.69	0.555	NS
Open Mouth Smile						
Pre op	22.53	8.33	22.74	4.82	0.21	NS
Post op (0-6 months)	26.56	5.42	27.925	4.1	1.365	NS
1 Year	32.71	7.33	31.17	2.05	1.54	NS
3 Years	31.32	6.88	26.59	3.6	4.73	0.0005

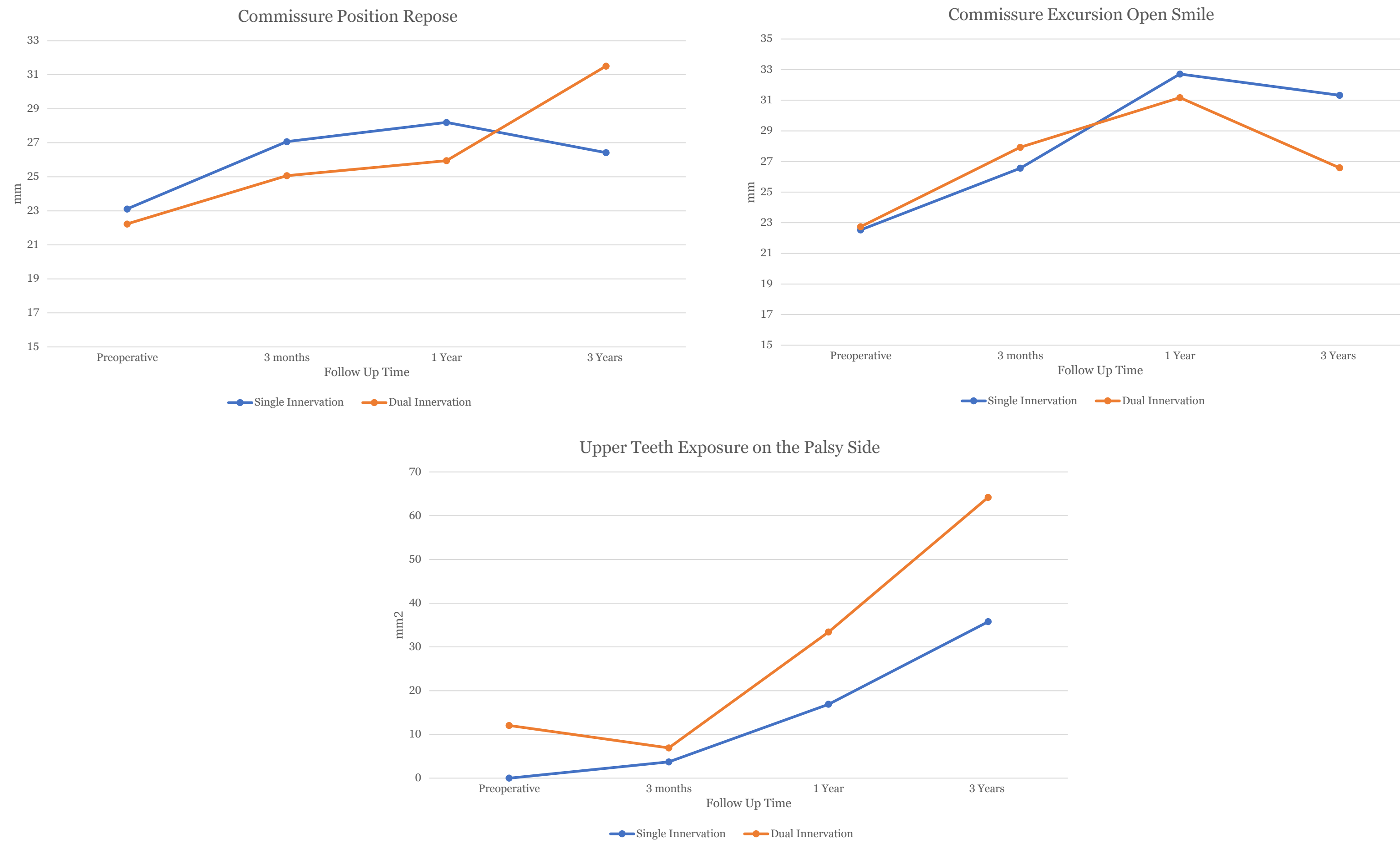
Single innervation group – changes from preoperative baseline in teeth exposure

Teeth Exposure	Median	Change from Baseline	IQR	P Value
Single Innervation	(mm ²)	(mm ²)	(mm ²)	
Pre op	0	NA	NA	NA
Post op (0-6 months)	3.709	3.709	9.292	0.029
1 Year	16.878	16.878	32.684	<0.001
3 Years	35.753	35.753	45.145	0.002

Dual innervation group – changes from preoperative baseline in teeth exposure

Teeth Exposure	Median	Change from Baseline	IQR	P Value
Dual Innervation	(mm ²)	(mm ²)	(mm ²)	
Pre op	12.027	NA	NA	NA
Post op (0-6 months)	6.912	-5.115	7.227	NS
1 Year	33.402	21.375	39.12	0.014
3 Years	64.177	52.15	52.761	0.004

Figure 3: Changes over time within each group. Figure 3a (top left) depicts the changes in commissure position at rest on the palsy side between single and dual-innervated groups over 3 years. Figure 3b (top right) depicts changes in commissure excursion with open mouth smile on the palsy side between single and dual-innervated groups over 3 years. Figure 3c (bottom) depicts changes in upper teeth exposure with open smile on the palsy side between single and dual-innervated groups over 3 years.



Conclusions

In the long term, dually-innervated FFMT revealed improvements in resting tone and teeth exposure during open smile with minimal decrease in smile excursion compared with single-innervated FFMT.

References

1. Terzis JK and Noah ME. Analysis of 100 cases of free-muscle transplantation for facial paralysis. *Plast Reconstr Surg* 1997; 99: 1905-1921. DOI: 10.1097/0006534-199706000-00016.
2. Hontanilla B, Marre D and Cabello A. Facial reanimation with gracilis muscle transfer neurotized to cross-facial nerve graft versus masseteric nerve: a comparative study using the FACIAL CLIMA evaluating system. *Plast Reconstr Surg* 2013; 131: 1241-1252. DOI: 10.1097/PRS.0b013e31828bd4da.
3. Klebuc MJ, Xue AS and Doval AF. Dual Innervation of Free Functional Muscle Flaps in Facial Paralysis. *Facial Plast Surg Clin North Am* 2021; 29: 431-438. DOI: 10.1016/j.fsc.2021.03.006.
4. Rozen S and Harrison B. Involuntary movement during mastication in patients with long-term facial paralysis reanimated with a partial gracilis free neuromuscular flap innervated by the masseteric nerve. *Plast Reconstr Surg* 2013; 132: 110e-116e. DOI: 10.1097/PRS.0b013e318290f644.
5. Dusseldorp JR, van Veen MM, Guarin DL, et al. Spontaneity Assessment in Dually Innervated Gracilis Smile Reanimation Surgery. *JAMA Facial Plast Surg* 2019; 21: 551-557. DOI: 10.1001/jamafacial.2019.1090.
6. Rozen SM. Facial Reanimation: Basic Surgical Tools and Creation of an Effective Toolbox for Treating Patients with Facial Paralysis: Part B. Nerve Transfer Combined with Cross-Facial Nerve Grafting in the Acute Facial Palsy Patient. *Plast Reconstr Surg* 2017; 139: 725-727. DOI: 10.1097/prs.0000000000003128.
7. Dusseldorp JR, Guarin DL, van Veen MM, et al. Automated Spontaneity Assessment after Smile Reanimation: A Machine Learning Approach. *Plast Reconstr Surg* 2022; 149: 1393-1402. DOI: 10.1097/prs.00000000000009167.
8. Chuang DC, Lu JC, Chang TN, et al. Using the "Sugarcane Chewing" Concept as the Directionality of Motor Neurotizer Selection for Facial Paralysis Reconstruction: Chang Gung Experiences. *Plast Reconstr Surg* 2019; 144: 252e-263e. DOI: 10.1097/prs.00000000000005871.

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