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#PSRC2023 Novel Method of Dual Innervated Free Gracilis Muscle Transfer for Facial Reanimation: A Case Series

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Abstract:	Purpose:Dynamic facial reanimation is the gold standard treatment for a paralyzed face. The use of the cross-face nerve graft (CFNG) in combination with the masseteric nerve to innervate the free gracilis muscle has been reported to both provide spontaneity and strong neural input. We report a case series of dual innervation using a novel method where the branch to masseter is coapted to the side of the cross-face nerve graft. Methods:Eight patients received free gracilis muscle transfer using the new dual innervation method between September 2014 and December 2017. The CFNG, which was performed nine months prior, was sutured in an end-to-end fashion to the obturator nerve. A nerve graft was coapted to the ipsilateral masseteric nerve and then sutured in an end-to-side fashion to the CFNG proximal to its coaptation to the obturator nerve.Results:All patients recovered smile function with teeth clenching and spontaneously around the same time period. Spontaneous smiles appeared later in 2/8 patients and earlier in 1/8 patients being noted at an average of 8.25 months of follow-up vs 7.6 months. The estimate of true attainment is limited by the spacing of follow-up dates. Average follow-up time was 36.07 months (range: 10-71.5). FACE-Gram software smile analysis with and without biting demonstrated similar excursion on average (7.64mm vs.8.6mm respectively, p=0.93) both of which are significantly improved from pre-operation.Conclusion:This novel method of a dual-innervated free gracilis muscle transfer represents a viable technique that achieves a symmetric, spontaneous, and emotional smile.
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Comment 1 The title of the manuscript should include the study design.		"A Case Series" has been added to the title

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Plastic Surgery

June, 6 2023

Dr. Jeffrey E. Janis
Editor-in-Chief
Plastic and Reconstructive Surgery Global Open

Dear Dr. Janis,

Please find our enclosed manuscript entitled "Novel Method of Dual Innervated Free Gracilis Muscle Transfer for Facial Reanimation: A Case Series" to be considered for publication as an original article in Plastic and Reconstructive Surgery.

Restoration of a naturally emotive and symmetric face is the goal of facial reanimation. In recent years, this goal has been increasingly well attained through the use of dual innervation. We report here a novel technique of dual innervation which places the masseter nerve at a disadvantage allows improved emotional expression and symmetry from the CFNG. We believe that the knowledge attained from this novel technique will continue to further the field of facial reanimation and improve patient outcomes.

We attest that the research described in this manuscript is original, has not been previously published, and is not being considered for publication elsewhere. The authors have no conflicts of interest to declare.

As Corresponding Author, I confirm that the manuscript has been read and approved for submission by all the named authors.

Thank you for your consideration.

Samir Mardini

Samir Mardini, M.D.
Professor and Chair
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*The following message is being sent on behalf of Jeffrey E. Janis, MD; Editor-in-Chief of *PRS Global Open**

Dear Dr. Hebel,

Congratulations on having your abstract, "Novel Method Of Double Innervated Free Gracilis Muscle Functional Transfer For Facial Reanimation," accepted for publication by the Plastic Surgery Research Council! As you know, PSRC and PRS Global Open have worked together to publish your work in a special abstract supplement for the PSRC 2023 Meeting. This supplement is live on PRSGlobalOpen.com, and- as an open access journal- it is free to read by anyone, anywhere. Read it today: https://bit.ly/PSRC2023
Based on the strength of your abstract, I would like to invite you to **submit the full article upon which your abstract was based to *PRS Global Open***.
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Congratulations again!

Jeffrey E. Janis, MD
Editor-in-Chief
Plastic and Reconstructive Surgery—Global Open

Takeaways

INSERT ARTICLE TITLE **Novel Method of Dual Innervated Free Gracilis Muscle Transfer for Facial Reanimation**
Question: **Does novel innervation of the gracilis with cross face nerve graft in combination with the masseteric nerve reliable in providing a smile without clenching?**
Findings: The CFNG: end-to-end fashion to the obturator nerve. A nerve graft was coapted to the ipsilateral masseteric nerve and then sutured in an end-to-side fashion to the CFNG. All 8 patients recovered smile function with and without teeth clenching around the same time period of around 8.25 months.
Meaning: This novel method is a viable technique that achieves a symmetric, strong, and non-clenching smile.

MANUSCRIPT (including title page, conflict of interest statement,
& legends)

Novel Method of Dual Innervated Free Gracilis Muscle Transfer for Facial Reanimation: A Case Series

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Short Running Head: Dual Innervation Facial Reanimation

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This study conforms to the Mayo institutional review board.

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Abstract:

Purpose:

Dynamic facial reanimation is the gold standard treatment for a paralyzed face. The use of the cross-face nerve graft (CFNG) in combination with the masseteric nerve to innervate the free gracilis muscle has been reported to both provide spontaneity and strong neural input. We report a case series of dual innervation using a novel method where the branch to masseter is coapted to the side of the cross-face nerve graft.

Methods:

Eight patients received free gracilis muscle transfer using the new dual innervation method between September 2014 and December 2017. The CFNG, which was performed nine months prior, was sutured in an end-to-end fashion to the obturator nerve. A nerve graft was coapted to the ipsilateral masseteric nerve and then sutured in an end-to-side fashion to the CFNG proximal to its coaptation to the obturator nerve.

Results:

All patients recovered smile function with and without teeth clenching around the same time period. Smiles without teeth clenching appeared later in 2/8 patients and earlier in 1/8 patients being noted at an average of 8.25 months of follow-up vs 7.6 months. The estimate of true attainment is limited by the spacing of follow-up dates. Average follow-up time was 36.07 months (range: 10-71.5). FACE-Gram software smile analysis with and without biting demonstrated similar excursion on average (7.64mm vs.8.6mm respectively, $p=0.93$) both of which are significantly improved from pre-operation.

Conclusion:

This novel method of a dual-innervated free gracilis muscle transfer represents a viable technique that achieves a symmetric, strong, and emotional smile.

Introduction:

The function of the face is crucial for daily interactions and function, as subtle facial expressions convey a myriad of non-verbal cues from dramatic to nuanced.[1] As a result, facial paralysis has a significant impact on quality of life for patients, and regaining a symmetric smile remains one of the most impactful reconstructive priorities.[2] Dynamic facial reanimation is the gold standard treatment for a severely paretic or paralyzed face. A variety of muscle and nerve coaptation configurations have been employed in an effort to achieve the optimal outcome with the least donor site morbidity.

Harri *et al.* pioneered the use of free functional muscle transfer in facial paralysis using the gracilis powered by the deep temporal nerve.[3] Today, the gracilis is the muscle of choice due to the low donor site morbidity, consistent anatomy, and the excellent size match of donor and recipient vessels.[4-7] The masseteric nerve has been used to innervate the gracilis as it provides rapid, strong and predictable re-innervation, and it has traditionally been used in cases of bilateral facial nerve palsy such as in Moebius syndrome.[8] However, this intervention does not often permit spontaneous, emotional activation, instead it requires patients to clench their teeth in order to generate a smile.[9,10]

When the contralateral facial nerve is intact, a cross-face nerve graft (CFNG) may be used to innervate the gracilis muscle. Scaramella in 1970 described the first CFNG for unilateral facial palsy.[11] Though this technique often achieves the desired muscle spontaneity, the long distance required for axonal regeneration may result in fewer nerve signals reaching the target.[12]

More recently, there have been several reports in the literature using cross-face nerve grafts combined with the masseteric nerve in the setting of free functional gracilis transfer.[13-19] The powerful impulse by the masseteric nerve in conjunction with the spontaneous control from the contralateral side results in faster recovery, a stronger contraction, and a more symmetric and spontaneous smile. The concept of dual innervation is supported in the basic science animal literature. [20-22] In many of the dual innervation techniques, the arrangement of nerves allows the branch to masseter to dominate the nerve input to the gracilis muscle.[13,15-17,19,23,24]

We report a novel modification to the existing nerve coaptation configurations. In our technique, the sural nerve is used as the CFNG from the contralateral facial nerve to the obturator nerve of the transferred gracilis. Innervation from the ipsilateral masseteric nerve is added, via a second nerve graft sutured end-to-end to the masseteric and end-to-side to the CFNG (Figure 1). It is generally thought that each coaptation site reduces axonal load by approximately 50%.[25,26] The additional nerve graft between the masseteric branch and the cross-face nerve graft, along with the proximal location on the CFNG serves to place the masseteric nerve at a disadvantage. The nerve input from the masseteric branch traverses three coaptation sites before reaching the gracilis giving it a major disadvantage. Additionally, at the typical regeneration rate of 1 mm/day, the extra length of the nerve graft placing it proximal to the CFNG to obturator coaptation prolongs the time it takes for the masseteric nerve axons to reach the gracilis muscle

target, thereby allowing more time for the CFNG to establish reinnervation.[25] We hypothesize that this disadvantage to the masseteric nerve would allow the CFNG to contribute more input for reinnervation to the gracilis. We present our outcomes in an 8 patient case series.

Methods:

After approval by the Institutional Review Board, retrospective analysis was performed to identify patients who underwent facial reanimation using our new method of dual innervated free gracilis muscle transfer between 2014 and 2017. Patients were excluded if they had less than 6 months of follow-up. Medical records were reviewed for age, sex, race, etiology of facial paralysis, duration of facial palsy, date of each surgical procedure, complications, type of nerve coaptation, and follow-up time.

Pre- and post-operative video interview analysis was performed by observers at all clinic visits to assess for smile characteristics. The FACE-Gram smile excursion software was utilized to analyze the maximal smile excursion in images pre- and post- operatively.[27] Time-to-smile with teeth clenching and time-to-smile without clenching from the intrinsic input from the contralateral side were estimated from their presence at follow-up visits.

Statistical analysis

Student t-test was used for smile excursion analysis. A p-value <0.05 was considered statistically significant. All statistical analysis was performed using JMP (SAS Institute Inc.).

Surgical Technique:

The first stage consisted of CFNG using the contralateral zygomatic branch(es) of the facial nerve identified via a preauricular facelift incision and sub-SMAS dissection. The sural graft was harvested via standard techniques and coapted to the selected zygomatic nerve branches. The sural nerve was then tunneled contralaterally through a subcutaneous tunnel in the upper lip.

Stage two was performed nine to twelve months following the placement of the CFNG. During the second stage, the gracilis muscle was harvested from the contralateral leg in 7 patients and ipsilateral in one patient (contralateral gracilis had been used for a previous surgery). The contralateral leg is used in order to allow for the proximal facia of the gracilis to be used at the upper lip and nasolabial fold. The muscle was marked at 1 cm intervals in order to later establish the appropriate tension upon inset. Inset in the face was as described by Terzis via a preauricular facelift incision. The muscle was anchored to the modiolus distally and the deep temporal fascia proximally.[2,28] The facial artery and vein were used as recipient vascular pedicles.

The CFNG was identified in the preauricular region via the facelift incision and coapted in an end-to-end fashion to the obturator nerve of the transferred gracilis. The ipsilateral masseteric nerve was coapted to a nerve graft obtained from the extra length of the obturator nerve from the gracilis muscle harvest. This masseter-coapted nerve graft was then sutured in an end-to-side fashion to the CFNG proximal (about 1-1.5 cm proximal) to the CFNG coaptation with the obturator nerve (Figure 1). All nerve coaptations were then covered with an NeuraGen® Nerve Protector (Integra LifeSciences Inc., Princeton, New Jersey.) or Axoguard® (AxoGen, Inc., Alachua, Fla.).

Postoperative care:

All flaps were monitored inpatient with a Cook-Swartz implantable doppler assessing the venous signal for five days before patients were discharged. Patients were actively followed in our Facial Paralysis and Reanimation Clinic by a multidisciplinary team consisting of plastic surgery, neurology, oculoplastics, optometry, and physical therapy. Patients were taught to perform biofeedback in front of a mirror on a daily basis. Patients were also instructed to practice smiling without biting in their daily living.

Follow-up evaluation:
Routine follow-up consisted of multidisciplinary clinic evaluation at approximately 1 month, 6-9 months, and 10-12 months (Table 2). At all follow-up visits, video recordings of the following were performed: 1) Smiling with teeth clenched to confirm innervation by the masseteric nerve, and 2) Attempt at a natural smile with teeth showing (lips apart) but without clenching in order to evaluate for muscle innervation from the CFNG. Outcomes were graded objectively via the FACE-Gram smile excursion automated measurement software and subjectively by members of the surgical team.[27]

Results:
Eight patients (7 female, 1 male) were included in the study. The patients are shown in repose position in Figure 2 and Supplemental Digital Content 1 and 2. (**See figure, Supplemental Digital Content 1.** Outcomes of our 8 patients who underwent two stage cross-face nerve graft combined with end-to-side nerve to the masseter transfer for free gracilis facial reanimation reconstruction. Standardized photographs of the patients in neutral repose pre-operatively and smiling without and with biting preoperatively and postoperatively are shown. INSERT LINK HERE) (**See figure, Supplemental Digital Content 2.** Outcomes of the 8 patients shown in standardized neutral repose both pre-operatively (top) and post-operatively (bottom). INSERT LINK HERE)

Mean age at the time of free gracilis transfer was 40.4 years old (range 25-58 years-old) (Table 1). All patients had longstanding facial paralysis of greater than 2 years. Four patients had left-sided and four had right-sided paralysis. Etiologies of facial paralysis varied: Bell's palsy (n=3), acoustic neuroma resection (n=2), parotid mass resection (n=1), congenital (n=1), and unknown (n=1). Mean time from CFNG to the gracilis transfer was 9.6 months (range 7.5-15 months). Average follow-up time was 36.07 months (range: 10-71.5). One complication of a hematoma requiring operative drainage occurred; no flap losses occurred. Three of the eight patients (patients 3, 5, and 6) had synkinesis prior to their operations. All three patients underwent neurectomy during either stage 1 or 2 of their dual innervation surgeries. Patient 5 required platysma myectomy 2 years post-operatively and patient 6 required repeat neurectomy 4 years post-operatively (see table footnote for details regarding synkinesis). (Video 1) (See **Video 1. [online] which demonstrates the** post-operative video taken in clinic of Patient 1. showing his sequence of voluntary smile as well as his spontaneous and naturally emotive smile.)

All patients were discharged from inpatient care at five days with follow up at 1 month (Table 2). Continual follow-up visits showed the attainment of a smile without teeth clenching and a smile

with teeth clenching in all patients (8/8). Smile with clenching was noted as early as a 3-month follow-up visit and as late as a 12-month visit (average 7.6 months follow-up) (Table 2). Two patients had not recovered smile function at their 4- and 8-month follow-up appointments but eventually were able to smile with teeth clenching at their 10- and 12-month follow-ups, respectively.

Smiles without clenching were observed in 8/8 patients being noted as early as a 6-month follow-up visit and as late as 12 months of follow-up (average 8.25 months follow-up) (Table 2.). One patient self-reported this smile before their 7 months follow-up visit at 4.5 months. The recognition of a smile without clenching occurred at roughly the same time as the reinnervation by the masseteric nerve in the majority of patients. In patients 5 and 8, apparent reinnervation by the masseteric nerve through smiling with teeth clenching preceded recognition of an effortless smile at their prior follow up 3 and 4 months earlier respectively. Patient 7 achieved a smile without clenching at a follow-up visit 2 months before reinnervation of the masseteric nerve was noticed.

On evaluation using the FACE-Gram software**,** smile excursion pre-operatively was 8.7mm on the non-paralyzed side and 0.1mm on the paralyzed side. This improved post-operatively to 7.6mm for smile without biting on the paralyzed side ($p=0.0015$), and to 8.64 mm for smile with biting ($p=0.0013$). There was no statistical difference between excursion from smile with biting and without biting ($p=0.93$). There was little change in the nonparalyzed side (8.7 mm preoperatively vs. 7.7 mm postoperatively with no biting, and 5.2 mm with biting).

Discussion:

In the facial reanimation literature, there has been growing interest in providing dual innervation to a free gracilis muscle transfer using both a CFNG and the ipsilateral masseteric nerve.[14-19,30,31] The powerful impulse by the masseteric nerve results in faster recovery, a stronger contraction, and a more symmetric smile, while the CFNG contributes spontaneity.[6,9,10,32]

The reported approaches can be categorized into three methods, as summarized in Figure 3. The most common approach uses the CFNG as an end-to-side coaptation and masseteric nerve as an end-to-end coaptation to the obturator nerve.[15,16,18] Another approach coapts the CFNG end-to-end and the masseteric nerve end-to-side to the obturator nerve.[17] Lastly, both the CFNG and masseteric nerve are coapted end-to-end to the obturator nerve using the distal stump of the intramuscular branch of the obturator nerve.[19]

In these previously described dual innervation techniques, there is a question of whether the strong neural input of the masseteric nerve takes over completely, thus limiting the ability of the CFNG to provide adequate innervation. This is especially true in a single stage, dual innervation approach where the reinnervation distance for the CFNG is much longer than that of the masseteric nerve. Snyder-Warwick *et al*[26] studied the myelinated fiber counts in their pediatric facial reanimation patients. The downstream count in the CFNG at the second stage was only 24% of the count at the facial nerve donor branch, while the count from the masseteric nerve was 78% compared to the

facial nerve.[26] In addition, in a rat animal model, there is evidence that end-to-end coaptation results in faster innervation and better muscle recovery following denervation compared to end-to-side innervation.[33-38]

In our coaptation variation, the procedure occurs in two stages, allowing the CFNG signal to reach the paralyzed side before transferring the gracilis. The masseteric nerve is also connected in an end-to-side fashion. This, in addition to the nerve graft between the masseteric and obturator nerves, theoretically gives an advantage to the CFNG signal. Our findings on smile excursion using the FACE-Gram software[27] did not show significant differences between smile excursion with biting and without biting. The analysis did show a trend toward a stronger excursion with biting smile, which is consistent with previous reported work evaluating excursion strength with the CFNG only vs. masseteric nerve only.[9,39,40] The stronger excursion with the additional input from the masseteric nerve is well supported by various basic science animal studies that show stronger nerve input and faster muscle recovery with dual innervation, as opposed to single innervation.[20-22,26] Time to reinnervation was shown to be important for muscle force.[41] We postulate that the masseteric nerve provides additional input to the muscle and prevents atrophy of the gracilis after transfer. The nerve signal provided by the CFNG then leads to stronger contraction of the muscle and smile commissure excursion. Our findings of 7.6mm of excursion are comparable and slightly improved to previously reported excursion values of 6.6 mm for CFNG.[7,42] Our excursions during biting are slightly lower than the reported value of around 11 mm for masseteric only innervation[42] likely due to our additional nerve graft, or by chance given the low patient numbers. An interesting future animal model would be to perform a dual innervated muscle transfer, then eliminate one innervation source and see if the previously dual innervated muscle maintained stronger force than the single innervated muscle just due to muscle mass preservation. We believe our method allows the most signal from the CFNG to contribute to reinnervation of the gracilis without risking prolonged denervation and atrophy.

In previous reports of dual innervation techniques, there has been an attempt to assess how much each neural input contributes to the reinnervation of the gracilis muscle and the subsequent smile. To address this question, authors have compared the time to gracilis movement with clenching (masseteric nerve) and the time-to-smile without teeth clenching (CFNG). Three groups have also previously used electromyography (EMG) to evaluate the contribution of the CFNG to reinnervation, but the reported results are inconsistent due to difficulty with EMG analysis.[13,17,19]

Biglioli *et al.* in 2012 were the first to report on dual innervation of the gracilis in four patients using the CFNG as an end-to-side coaptation to the obturator nerve and masseteric nerve as an end-to-end coaptation to the obturator nerve.[15] The authors noted reinnervation by clenching on average 3.8 months post-operatively, and a similar time-to-gracilis reinnervation was reported by all authors, ranging from 3.2 to 5.1 months post-operatively, with almost 100% success.[13,15,17-19] This is consistent with the previously reported reinnervation time of the gracilis by masseteric nerve alone, and much shorter than the time required for CFNG reinnervation.[6,8-10,28,32,43,44]

Our own results, with the mean time-to-smile with clenching of 7.6 months and range of 3-12 months, exceed the numbers reported in the literature.[44] It is possible that this increased time is attributable to the disadvantage we placed on the masseteric nerve, prolonging time to reinnervation. A meta-analysis looking at masseteric nerve only transfer noted delayed recovery

of 6.24 months, from 4.06 months in those with interposition graft.[44] However, it is also possible that this may instead be a result of our Facial Paralysis and Reanimation Clinic protocol. Typically, within the first year, we schedule follow-up visits at 1 month and 6 months postoperatively with variability by patient schedule. As a result, we may be missing the early reinnervation that is reported to occur between approximately 3 to 5 months. Of note, patient 5 had a small hematoma that required operative drainage and thus was more frequently followed. Therefore, this patient had a 3-month follow-up visit, at which time the gracilis demonstrated evidence of reinnervation by the masseteric nerve.

To try and address the CFNG input to the gracilis muscle, previous studies have attempted to assess whether the patient is able to smile effortlessly (without clenching their teeth to activate the masseteric nerve). Bianchi *et al.*, Biglioli *et al.* and Sforza *et al.*, and Uehara *et al.* assessed spontaneous smile by counseling the patients to smile without clenching their teeth and by using emotional stimuli (i.e. watching a funny video) to trigger a spontaneous smile.[14,15,18,19] There was high level of effortless smiles reported in these studies with only two failures noted in Sforza *et al.* series of 13 patients.[18] The two articles that discussed time-to-spontaneous smile used a single stage procedure and noted an average time of 7.2 months[15] and 9.5 months.[19] In our two-stage method, all 8 patients (100%) achieved an effortless smile. The localizing time of attainment can be estimated at between 5-7 months. As seen in Table 2, 2nd follow-up visits commonly occurred in the 6–9-month time frame. All patients but one who were seen at 7 months or later had developed a smile without clenching their teeth. Only 3 patients had been seen between 1-6 months without evidence of this smile (additional 3–4-month follow-up visits). All three of these patients had achieved the smile without clenching by their next visits at 6 or 7 months. The limitation of spaced follow-up restricts our estimate of time to effortless smile attainment to be a range of around 5-7 months. We are limited in the statement due to one patient not having achieved an effortless smile at 8 months. As well, 2 patients had 2nd follow-up visits at >10 months, however, they both had achieved a smile without clenching at that time. Interestingly, one patient self-reported a spontaneous smile at 4.5 months which was 2.5 months before their scheduled follow-up of 7 months showing our range may be an overestimate for our patients. We see here that the likely window of spontaneous achievement is between 5 and 7 months with the most frequently reported attainment being at 7 month follow up. In conjunction, our estimated range of attainment is consistent with the reported findings of Biglioli *et al.* and Uehara *et al.*'s findings.[15,19]

Of note, there have been previous claims of spontaneity in the masseteric nerve transfer alone, especially in children.[7,12] In contrast, Chuang *et al.*, described a series of 22 patients with masseteric nerve innervated gracilis, and none of the patients achieved a spontaneous smile using a "tickle test" (average follow up >2 years).[9] It is therefore difficult to know whether the patients who were reported to have a spontaneous smile or smile without clenching achieved this based on the additional CFNG or cortical plasticity,[45,46] a limitation which is difficult to decern in human case studies.

Our study shared common limitations with other authors, including a low volume of cases and variable patient etiology of paralysis. Our patients also had many ancillary procedures, including Botulinum toxin injections, selective neurectomy, and symmetry procedures such as rhytidectomy,

browlift, and canthopexy, which might influence our outcome measurements. The timing of clinic follow-up post-surgically may have also overestimated the time-to-smile, as mentioned previously.

Conclusion:

Our new novel method of a dual innervated free gracilis muscle transfer for facial reanimation represents a viable technique that does not risk denervation of the gracilis muscle and results in a strong symmetric smile with and without teeth. We hypothesize that using an extra nerve graft between the masseteric and obturator nerves places the masseteric nerve at a disadvantage and allows the cross-face nerve graft to provide input to the reinnervated gracilis muscle without being taken over by the masseteric nerve input.

References

1. Schmidt KLC, J.F. Human Facial Expressions as Adaptations: Evolutionary Questions in Facial Expression Research. *Yearbook of Physical Anthropology.*44:3-24.
2. Wei F-C, Mardini S. Flaps and reconstructive surgery. 2017.
3. Harii K, Ohmori K, Torii S. Free gracilis muscle transplantation, with microneurovascular anastomoses for the treatment of facial paralysis. A preliminary report. *Plastic and reconstructive surgery.* 1976;57(2):133-143.
4. Bianchi B, Copelli C, Ferrari S, Ferri A, Bailleul C, Sesenna E. Facial animation with free-muscle transfer innervated by the masseter motor nerve in unilateral facial paralysis. *Journal of oral and maxillofacial surgery : official journal of the American Association of Oral and Maxillofacial Surgeons.* 2010;68(7):1524-1529.
5. Gousheh J, Arasteh E. Treatment of facial paralysis: dynamic reanimation of spontaneous facial expression-apropos of 655 patients. *Plastic and reconstructive surgery.* 2011;128(6):693e-703e.
6. Hadlock TA, Malo JS, Cheney ML, Henstrom DK. Free gracilis transfer for smile in children: the Massachusetts Eye and Ear Infirmary Experience in excursion and quality-of-life changes. *Archives of facial plastic surgery.* 2011;13(3):190-194.
7. Manktelow RT, Tomat LR, Zuker RM, Chang M. Smile reconstruction in adults with free muscle transfer innervated by the masseter motor nerve: effectiveness and cerebral adaptation. *Plastic and reconstructive surgery.* 2006;118(4):885-899.
8. Zuker RM, Goldberg CS, Manktelow RT. Facial animation in children with Mobius syndrome after segmental gracilis muscle transplant. *Plastic and reconstructive surgery.* 2000;106(1):1-8; discussion 9.
9. Chuang DC-C, Lu JC-Y, Chang TN-J, Laurence VG. Comparison of Functional Results After Cross-Face Nerve Graft-, Spinal Accessory Nerve-, and Masseter Nerve-Innervated Gracilis for Facial Paralysis Reconstruction: The Chang Gung Experience. *Annals of Plastic Surgery.* 2018;81(6S Suppl 1):S21-S29.
10. Jose Carlos M. Faria GPS, Fabio F. Busnardo, Marcus C. Ferreira. Nerve Sources for Facial Reanimation With Muscle Transplant in Patients With Unilateral Facial Palsy: Clinical Analysis of 3 Techniques.[*Annals of Plastic Surgery.* 2007;59(1)(1):87-91.
11. Scaramella LF. Preliminary report on facial nerve anastomosis. . *Second International Symposium on Facial Nerve Surgery.* Osaka, Japan; 1970.
12. Singham J, Manktelow R, Zuker RM. Mobius syndrome. *Seminars in plastic surgery.* 2004;18(1):39-46.
13. Bianchi B, Ferri A, Ferrari S, et al. Cross-facial nerve graft and masseteric nerve cooptation for one-stage facial reanimation: principles, indications, and surgical procedure. *Head & neck.* 2014;36(2):235-240.

14. Bianchi B, Ferri A, Ferrari S, Copelli C, Salvagni L, Sesenna E. The masseteric nerve: a versatile power source in facial animation techniques. *The British journal of oral & maxillofacial surgery.* 2014;52(3):264-269.
15. Biglioli F, Colombo V, Tarabbia F, et al. Double innervation in free-flap surgery for long-standing facial paralysis. *Journal of plastic, reconstructive & aesthetic surgery : JPRAS.* 2012;65(10):1343-1349.
16. Boahene KO, Owusu J, Ishii L, et al. The Multivector Gracilis Free Functional Muscle Flap for Facial Reanimation. *JAMA facial plastic surgery.* 2018;20(4):300-306.
17. Cardenas-Mejia A, Covarrubias-Ramirez JV, Bello-Margolis A, Rozen S. Dual innervated free functional muscle transfer for facial reanimation. *Journal of plastic surgery and hand surgery.* 2015;49(3):183-188.
18. Sforza C, Frigerio A, Mapelli A, et al. Dual-powered free gracilis muscle transfer for smile reanimation: A longitudinal optoelectronic study. *Journal of plastic, reconstructive & aesthetic surgery : JPRAS.* 2015;68(7):930-939.
19. Uehara M, Shimizu F. The Distal Stump of the Intramuscular Motor Branch of the Obturator Nerve Is Useful for the Reconstruction of Long-Standing Facial Paralysis Using a Dual-Powered Free Gracilis Muscle Flap Transfer. *The Journal of craniofacial surgery.* 2018;29(2):476-481.
20. Nepomuceno AC, de Faria JC, Politani EL, et al. Convergent end-to-end neurorrhaphy: An alternative technique for dual innervation of the gastrocnemius muscle in rats. *Microsurgery.* 2019;39(6):535-542.
21. Fujiwara T, Matsuda K, Kubo T, et al. Axonal supercharging technique using reverse end-to-side neurorrhaphy in peripheral nerve repair: an experimental study in the rat model. *J Neurosurg.* 2007;107(4):821-829.
22. Farber SJ, Glaus SW, Moore AM, Hunter DA, Mackinnon SE, Johnson PJ. Supercharge nerve transfer to enhance motor recovery: a laboratory study. *J Hand Surg Am.* 2013;38(3):466-477.
23. Oh TS, Kim HB, Choi JW, Jeong WS. Facial reanimation with masseter nerve-innervated free gracilis muscle transfer in established facial palsy patients. *Archives of plastic surgery.* 2019;46(2):122-128.
24. Win TS, Kallirroi T. Power and Coordination for Facial Reanimation -Dual Innervation of Free Gracilis Transfer Using Masseteric Nerve and Cross-Facial Nerve Graft. *Plastic & Reconstructive Surgery.* 2012;134:13.
25. Grinsell D, Keating CP. Peripheral Nerve Reconstruction after Injury: A Review of Clinical and Experimental Therapies. *BioMed Research International.* 2014;2014:13.
26. Snyder-Warwick AK, Fattah AY, Zive L, Halliday W, Borschel GH, Zuker RM. The Degree of Facial Movement following Microvascular Muscle Transfer in Pediatric Facial Reanimation Depends on Donor Motor Nerve Axonal Density. *Plastic and reconstructive surgery.* 2015;135(2):370e-381e.
27. Hadlock TA, Urban LS. Toward a universal, automated facial measurement tool in facial reanimation. *Archives of facial plastic surgery.* 2012;14(4):277-282.
28. Terzis JK, Noah ME. Analysis of 100 cases of free-muscle transplantation for facial paralysis. *Plastic and reconstructive surgery.* 1997;99(7):1905-1921.
29. Terzis JK, Tzafetta K. The "babysitter" procedure: minihypoglossal to facial nerve transfer and cross-facial nerve grafting. *Plastic and reconstructive surgery.* 2009;123(3):865-876.
30. Boonipat T, Asaad M, Sabbagh MD, Robertson CE, Mardini S. Novel Method of Dual Innervated Free Gracilis Muscle Functional Transfer for Facial Reanimation. *Plastic and Reconstructive Surgery Global Open.* 2019;7(8 Saxogaurd uppl):60-60.
31. Boonipat T, Robertson CE, Meaike JD, Vyas KS, Asaad M, Mardini S. Dual innervation of free gracilis muscle for facial reanimation: What we know so far. *Journal of Plastic, Reconstructive & Aesthetic Surgery.* 2020.
32. O'Brien BM, Pederson WC, Khazanchi RK, Morrison WA, MacLeod AM, Kumar V. Results of management of facial palsy with microvascular free-muscle transfer. *Plastic and reconstructive surgery.* 1990;86(1):12-22; discussion 23-14.
33. Jaeger MRdO, Braga-Silva J, Gehlen D, et al. End-to-End Versus End-to-Side Motor and Sensory Neurorrhaphy in the Repair of the Acute Muscle Denervation. *Annals of Plastic Surgery.* 2011;67(4):391-396.
34. Liao W-C, Chen J-R, Wang Y-J, Tseng G-F. The efficacy of end-to-end and end-to-side nerve repair (neurorrhaphy) in the rat brachial plexus. *J Anat.* 2009;215(5):506-521.
35. Barbour J, Yee A, Kahn LC, Mackinnon SE. Supercharged End-to-Side Anterior Interosseous to Ulnar Motor Nerve Transfer for Intrinsic Musculature Reinnervation. *The Journal of Hand Surgery.* 2012;37(10):2150-2159.

36. Isaacs J. Reverse End-to-Side Neurotization. *J Reconstr Microsurg.* 2005;21(01):43-48.
37. Isaacs J, Feger MA, Mallu S, et al. Side-to-side supercharging nerve allograft enhances neurotrophic potential. *Muscle & Nerve.* 2020;61(2):243-252.
38. JK T. 'Babysitter': an exciting new concept in facial reanimation. *Proceedings of the Sixth International Symposium on the Facial Nerve.* 1988:525.
39. Bae YC, Zuker RM, Manktelow RT, Wade S. A comparison of commissure excursion following gracilis muscle transplantation for facial paralysis using a cross-face nerve graft versus the motor nerve to the masseter nerve. *Plastic and reconstructive surgery.* 2006;117(7):2407-2413.
40. Zhang S, Hembd A, Ching CW, Tolley P, Rozen SM. Early Masseter to Facial Nerve Transfer May Improve Smile Excursion in Facial Paralysis. *Plast Reconstr Surg Glob Open.* 2018;6(11):e2023-e2023.
41. Aydin M, Mackinnon S, Gu X, Kobayashi J, Kuzon W. Force deficits in skeletal muscle after delayed reinnervation. *Plastic and reconstructive surgery.* 2004;113:1712-1718.
42. Natghian H, Fransén J, Rozen SM, Rodriguez-Lorenzo A. Qualitative and Quantitative Analysis of Smile Excursion in Facial Reanimation: A Systematic Review and Meta-analysis of 1- versus 2-stage Procedures. *Plast Reconstr Surg Glob Open.* 2017;5(12):e1621.
43. Eisenhardt SU, Eisenhardt NA, Thiele JR, Stark GB, Bannasch H. Salvage procedures after failed facial reanimation surgery using the masseteric nerve as the motor nerve for free functional gracilis muscle transfer. *JAMA facial plastic surgery.* 2014;16(5):359-363.
44. Murphey AW, Clinkscales WB, Oyer SL. Masseteric Nerve Transfer for Facial Nerve Paralysis: A Systematic Review and Meta-analysis. *JAMA facial plastic surgery.* 2018;20(2):104-110.
45. Hontanilla B, Cabello A. Spontaneity of smile after facial paralysis rehabilitation when using a non-facial donor nerve. *Journal of Cranio-Maxillofacial Surgery.* 2016;44(9):1305-1309.
46. Buendia J, Loayza FR, Luis EO, Celorrio M, Pastor MA, Hontanilla B. Functional and anatomical basis for brain plasticity in facial palsy rehabilitation using the masseteric nerve. *Journal of plastic, reconstructive & aesthetic surgery : JPRAS.* 2016;69(3):417-426.

Figure Legends:

Figure 1. Dual Innervation using CFNG as an end-to-end coaptation to the obturator and the masseteric nerve as an end-to-end to a nerve graft coapted end-to-side to the CFNG.

Figure 2. Representative figures of patients 1 and 2 who underwent two stage cross-face nerve graft combined with end-to-side nerve to the masseter transfer for free gracilis facial reanimation reconstruction. Standardized photographs of the patients in neutral repose pre-operatively and smiling without and with biting preoperatively and postoperatively are shown.

Figure 3 A. Dual Innervation using CFNG as an end-to-end coaptation to the obturator and the masseteric nerve as an end-to-side to the obturator nerve. **B.** Dual Innervation using CFNG as an end-to-side coaptation to the obturator and the masseteric nerve as an end-to-end to the obturator nerve. **C.** Dual innervation using two end-to-end coaptations: CFNG with the obturator nerve, and the masseteric nerve with an intramuscular motor branch.

SDC 1 – See figure, Supplemental Digital Content 1. Outcomes of our 8 patients who underwent two stage cross-face nerve graft combined with end-to-side nerve to the masseter transfer for free gracilis facial reanimation reconstruction. Standardized photographs of the patients in neutral repose pre-operatively and smiling without and with biting preoperatively and postoperatively are shown. INSERT LINK HERE

SDC 2 – See figure, Supplemental Digital Content 2. Outcomes of the 8 patients shown in standardized neutral repose both pre-operatively (top) and post-operatively (bottom). INSERT LINK HERE

Video 1. This video demonstrates the post-operative video taken in clinic of Patient 1. showing his sequence of voluntary smile as well as his spontaneous and naturally emotive smile.

Table 1.

Table 1: Patient Demographics					
Patient No.	**Age**	**Sex**	**Affected side**	**Etiology**	**Duration of paralysis prior to gracilis transfer (years)**
1	43	M	R	Unknown	6
2	38	F	L	Acoustic neuroma	10
3	39	F	L	Bell's palsy	2
4	34	F	L	Parotid mass resection	34
5	55	F	R	Bell's Palsy	2
6	39	F	R	Bell's palsy	11
7	23	F	L	Congenital	25
8	52	F	R	Acoustic neuroma removal	16
Average (Range)	40.4 (35-55)	F(7), M(1)	L(4), R(4)		13.2 (2-34)

Table 2.

Table 2: Patient Outcomes						Excursion (mm) on paralyzed side using FACE-Gram				Synkinesis	
Patient No.	Paralyzed side	Earliest Follow-up Dates (months)	Longest Follow-up Date (months)	Follow-up Date Noting Movement of Transplanted Muscle with the Masseter Nerve (months)	Follow-up Date Noting Spontaneous Movement of Transplanted Muscle with the Masseter Nerve (months)	Pre operative smile (no biting)	Post operative smile (no biting)	Post operative smile (biting)	Ancillary procedures	Present	Intervention
1	R	1, 4, 7	26	7	7	-5.2	9.9	10.0	Fat grafting, cathopexy, botox	No	-
2	L	3, 7, 14	38	7	7 (4.5 self noted)	-3.2	6.8	7.4	Canthopexy, botox	Yes, recurrent	Neurolysis x2, Orbicularis Botox Injection
3	L	1, 7	10	7	7	-1.9	4.03	2.4	Canthopexy, botox	No	-
4	L	1, 7, 11	26	7	7	2.1	10.5	8.4	Browlift, blepharoplasty, botox	Yes, recurrent	Neurolysis x1, Botox Injection
5	R	1, 3, 6, 9, 12	73	3	6	0.8	2.25	9.6	Browlift, canthopexy, fat grafting, facelift, botox	No	-
6	R	0.5, 1, 10	60	10	10	-0.2	7.38	8.4	Botox, fat grafting	No	-
7	L	1, 10, 12	26	12	10	8.1	6.4	4.9	Facelift, canthopexy, fat grafting, botox	Yes	Neurolysis x1
8	R	1, 8, 12	57	8	12	0.2	13.85	18.0	Canthopexy	No	-
Average (Range)			36.1 (10-73)	7.6 (3-12)	8.25 (6-12)	0.1	7.64	8.6			

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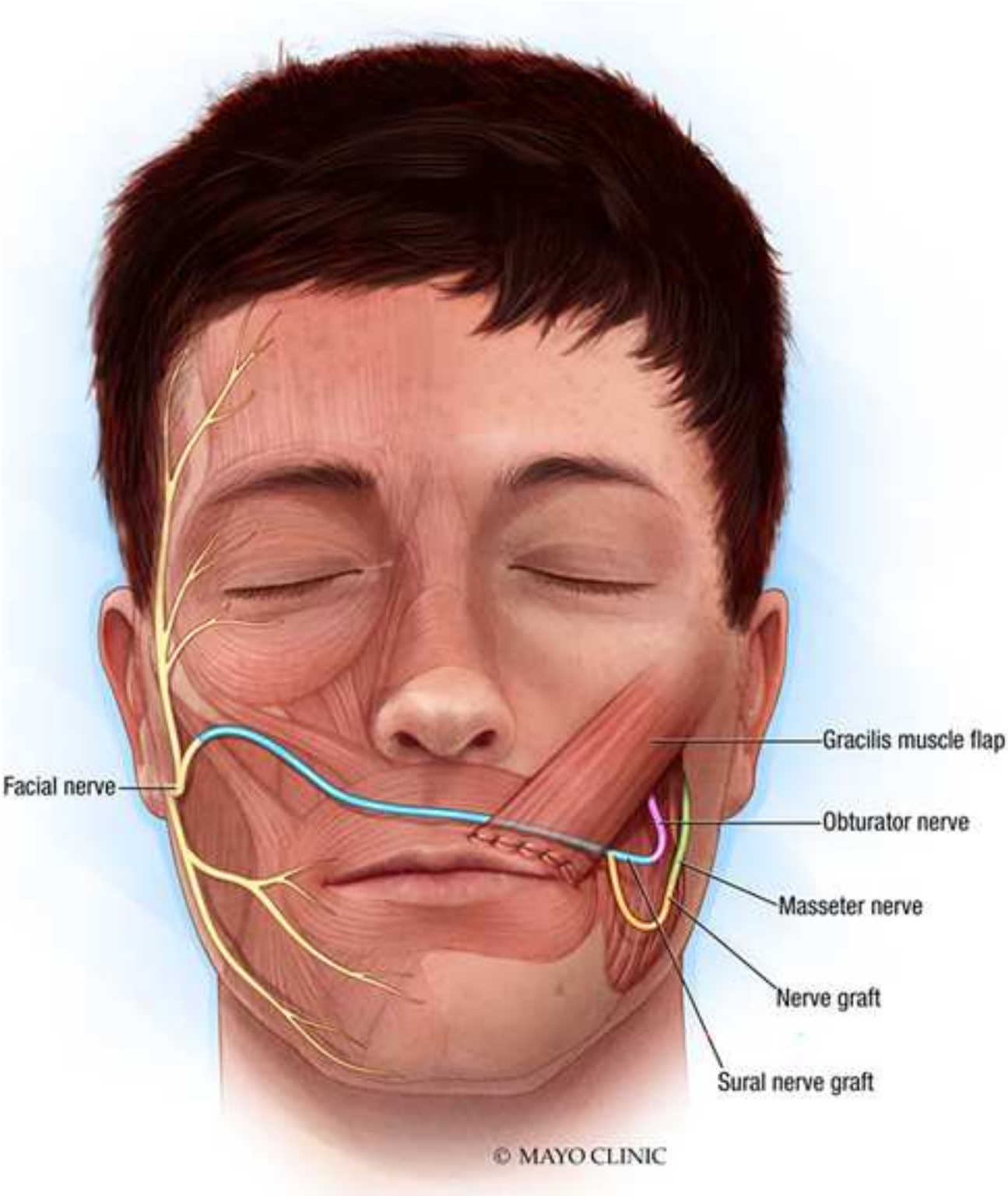

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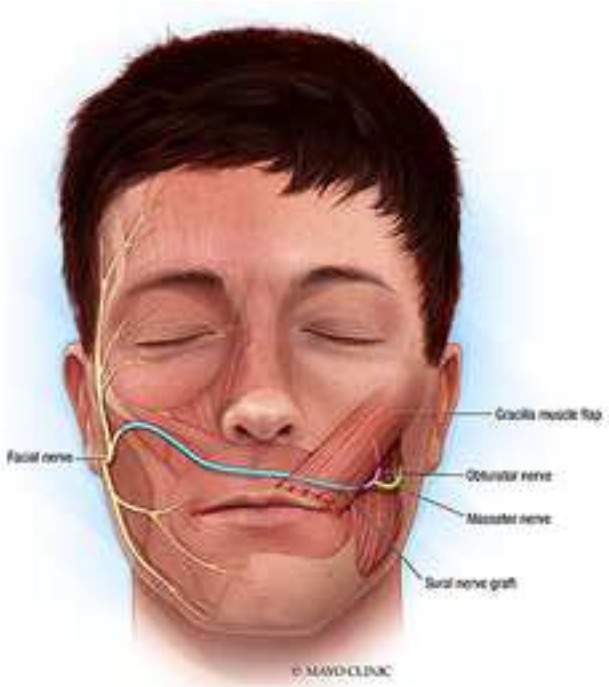

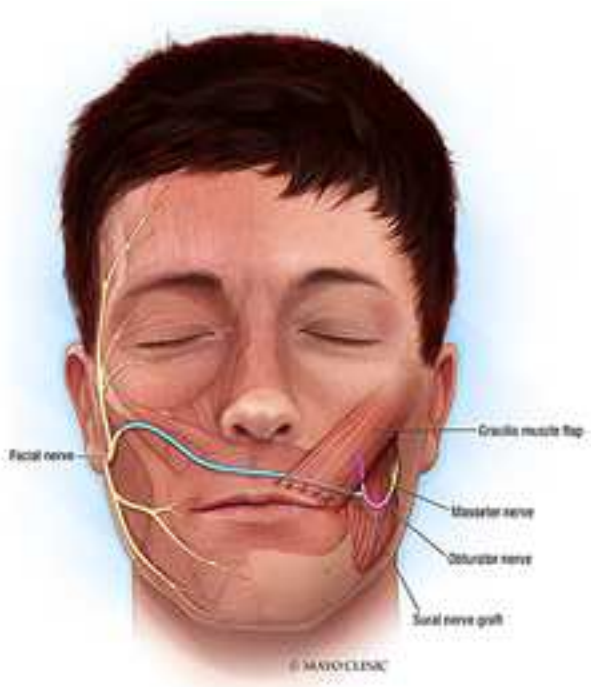

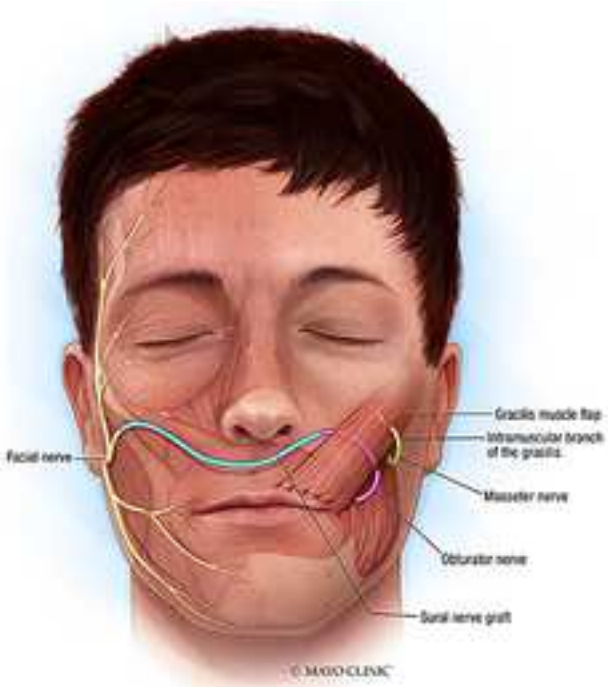

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01/31/31

Consent Other

8040-19

0097

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MAYO CLINIC

Patient Informed Consent

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Department: Plastic Surgery

☐ Rush for Next Day Surgery

Patient Name: Barbara J. Finseth

Birth Date (mm-dd-yyyy): 10-22-1960

Room Number (if applicable):

Mayo Clinic Number: 6-265-704

I consent to the following procedure(s):

Injection fat (to right face, donor site: TBD); Right facial tissue debulking; Possible selective neurectomy, cut cervical branch of the facial nerve; Possible Bilateral Facelift; proceed as indicated.

This procedure(s) will be performed by: MARDINI, SAMIR

Physician Pager Number: 46700

Name of Performing or Supervising Physician or Licensed Independent Practitioner

Risks, Benefits, Alternatives: My provider has explained to me the risks, benefits, and nature and consequences of the procedure, along with risk of complications, including, but not limited to failure, serious injury, and even death; the likelihood that I will achieve my goals; and any potential problems that might occur during recuperation. My provider also has explained the alternative viable modes of treatment, their benefits, risks and effectiveness, as well as the risks and benefits of not undergoing treatment. The likely results of no treatment have been explained to me.

Anesthesia: If an anesthetic is administered, as discussed with my provider, it will be administered through general or regional anesthesia, such as spinal or epidural, or local anesthesia with sedation. I understand that all types of anesthesia involve risk due to unexpected reactions or complications. Potential complications include damage to teeth, mouth or throat, allergic reactions, pneumonia, inflammation of the veins, nerve injury, or paralysis, damage to the heart, liver, kidney or brain, infection, or the possibility of death.

Additional Procedures: I understand that additional procedure(s) may be necessary or desirable during the procedure(s) to treat or evaluate me. It is or may be foreseeable that unanticipated conditions may be revealed that require an extension of the original procedure, so I consent to such additional procedure(s) as are necessary and desirable in my provider's professional judgment.

Health Care Team: I understand that other providers, including physicians-in-training, physician assistants, surgical technicians or others may be involved. They may be identified by name in my medical record. For some surgeries, a provider other than the primary surgeon may perform significant tasks including opening and closing the wound, harvesting grafts, removing tissue, and implanting devices or altering tissues.

Overlapping Operations/Procedures in the Operating Room: I understand that my primary surgeon may be participating in another operative procedure during non-critical portions of my procedure. A qualified surgeon will be available.

Photography and Video: I consent to being photographed or videotaped for purposes of treatment and internal health care operations, such as improvement of quality of care and education of students and professionals. I also consent to the photography or videotaping of the procedure showing portions of my body for medical, scientific or educational purposes, provided that my identity is not revealed.

Transfusion of Red Blood Cells (RBCs), Granulocytes, Platelets, Frozen Plasma (FP) or Cryoprecipitate: I have discussed with my provider the possibility of needing a blood transfusion or having autologous blood transfused using cell salvage during my treatment, and the risks and benefits of receiving blood or blood products, and viable medical alternatives. I understand the most common risks include but are not limited to: transfusion reactions such as fever, chills, allergic reaction, hives or shortness of breath, or discomfort at the site of administration. I also understand there is a risk of transfusion transmitted disease such as Hepatitis B, Hepatitis C or HIV.

Implants: If I have an implant/device placed, I authorize personnel to: (1) complete the registry card(s) associated with my implant/device that contains my personal health information; and (2) provide the card to the appropriate registry or data collection agency.

Exposure: If a Mayo Clinic employee is exposed to my blood or body fluids, I consent to have my blood drawn and tested and to the disclosure of my results to Mayo Clinic Occupational Health and the exposed employee for the purposes of treatment to the employee.

My questions have been answered. By signing below I agree to the procedure(s).

Patient/Representative Signature	Patient/Representative Printed Name	Date (mm-dd-yyyy)
Barbara Finseth	Barbara Finseth	03-29-2018
If Representative, Relationship to Patient	**Witness to Signature**	**Time (24-hour clock)**
	Beth Madsen	13:47

Contact the Help Desk (77)4-5500 for technical assistance.
Contact Christopher Chaffee, Management Engineering & Internal Consulting, (77)4-2142 for process-related assistance.

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5-382-953 05/21/77 F 35
Gianlorenzi, Mrs. Michelle Lee
210 East Chestnut Street
Virginia MN
(000.0) facial reconstruction

(Mayo Clinic Number and Name Above)

MAYO CLINIC

SCANNED
AUTHORIZATION

Authorization to Photograph, Videotape, or Film Patient

Note: You do not need to add patient name, birth date, record number, or procedure if included on a label above.

Patient Name: _____ Birth Date: _____

Mayo Clinic Medical Record Number: _____

Service/Procedure: _____

I consent to being photographed, videotaped or filmed by Mayo Clinic.

I consent to Mayo Clinic using the photographs, videotapes or films (collectively, the "Materials") for treatment purposes and for Mayo Clinic's internal health care operations, such as to improve quality of care to patients and to educate students and professionals at facilities staffed by Mayo Clinic. I also consent to Mayo Clinic using and disclosing the Materials for scientific, educational, and media-related purposes, provided my identity is not revealed.

I agree that the Materials shall be the sole and exclusive property of Mayo Clinic, free and clear of any claim on my part, and that I shall receive no royalties or other compensation or consideration for the Materials.

I release Mayo Clinic and its personnel from any and all liabilities which may arise from the use or disclosure of Materials and information under this authorization.

*Note: **The following four additional paragraphs apply only to Mayo Clinic's use and disclosure of Materials which reveal your identity (e.g., full-face photographs or other comparable images) for scientific and educational related purposes. If you do not wish to authorize the use and disclosure of such Materials for such purposes, you should line through these four paragraphs and/or initial this box [_____].***

I authorize Mayo Clinic to use and disclose Materials which reveal my identity for scientific and educational related purposes. I also authorize Mayo Clinic to use and disclose information about my medical care and treatment in connection with its use and disclosure of the Materials, including HIV/AIDS-related information and genetic testing-related information, if any such information exists. The disclosure of the Materials and information is authorized to the general public or medical, scientific or educational audiences via any method or media Mayo Clinic deems proper, including but not limited to continuing medical education conferences, lectures, presentations, and publications in professional journals, brochures, books, and magazines.

I understand that I may revoke this authorization at any time except to the extent that Mayo Clinic has already taken action in reliance on it. I understand that in order to revoke this authorization, I must do so in writing and present my written revocation to:

Arizona:
Mayo Clinic, Attention: Health Information Management Services
13400 East Shea Boulevard
Scottsdale, AZ 85259

Florida:
Mayo Clinic, Attention: Health Information Management Services
4500 San Pablo Road
Jacksonville, FL 32224

Rochester:
Mayo Clinic, Attention: Health Information Management Services
200 First Street SW,
Rochester, Minnesota 55905

I understand that the revocation of this authorization will not apply to Materials and information that have already been disclosed in accordance with the terms of this authorization. I understand that this authorization will remain in effect unless specifically revoked by me.

I understand that Mayo Clinic will not condition treatment, payment, enrollment or eligibility for benefits on whether I sign this authorization.

I understand that, if Materials and information are disclosed to a third party, the Materials and information may no longer be protected by federal privacy regulations and may be re-disclosed by the person or entity that receives the Materials and information.

Signature of Patient or Legal Representative: x Michelle Gianlorenzi Date: 3-26-13

Relationship to Patient (if not patient): _____

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MAYO CLINIC

Authorization to Photograph or Video Record Patient

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(complete fields or place patient label here)

Patient: NOBLE
Sharon E
06-047-734 DOB: 02/15/1961 F

Birth Da

Mayo ID

photos

if applicable)

COLLECT GO LBS 02/21/2018 08:37
ID: 397742 Sublake

I consent to being photographed or video recorded by Mayo Clinic.

I consent to Mayo Clinic using the photographs or video recordings (collectively, the "Materials") for treatment purposes and for Mayo Clinic's internal health care operations, such as to improve quality of care to patients and to educate students and professionals at facilities staffed by Mayo Clinic. I also consent to Mayo Clinic using and disclosing the Materials for scientific, educational, and media-related purposes, provided my identity is not revealed.

I agree that the Materials shall be the sole and exclusive property of Mayo Clinic, free and clear of any claim on my part, and that I shall receive no royalties or other compensation or consideration for the Materials.

I release Mayo Clinic and its personnel from any and all liabilities which may arise from the use or disclosure of Materials and information under this authorization.

Note: ***The following four additional paragraphs apply only to Mayo Clinic's use and disclosure of Materials which reveal your identity (eg, full-face photographs or other comparable images) for scientific and educational related purposes. If you do not wish to authorize the use and disclosure of such Materials for such purposes, you should line through these four paragraphs and/or initial this box [_____].***

I authorize Mayo Clinic to use, publish and otherwise disclose Materials which reveal my identity for purposes related to the Mayo Clinic mission. I also authorize Mayo Clinic to use and disclose information about my medical care and treatment in connection with its use and disclosure of the Materials, including HIV/AIDS-related information and genetic testing-related information, if any such information exists. The disclosure of the Materials and information is authorized to third parties including but not limited to the general public or medical, scientific or educational audiences via any method or media Mayo Clinic deems proper, including but not limited to continuing medical education conferences, lectures, presentations, and publications in professional journals, brochures, books, magazines, and the online equivalents.

I understand that I may revoke this authorization at any time except to the extent that Mayo Clinic has already taken action in reliance on it. I understand that in order to revoke this authorization, I must do so in writing and present my written revocation to:

Mayo Clinic
Attention: Health Information Management Services
200 First Street SW
Rochester, Minnesota 55905

I understand that the revocation of this authorization will not apply to Materials and information that have already been disclosed in accordance with the terms of this authorization. I understand that this authorization will remain in effect unless specifically revoked by me.

I understand that Mayo Clinic will not condition treatment, payment, enrollment or eligibility for benefits on whether I sign this authorization.

I understand that, if Materials and information are disclosed to a third party, the Materials and information may no longer be protected by federal privacy regulations and may be re-disclosed by the person or entity that receives the Materials and information.

Patient or Legal Representative Signature	Date (mm-dd-yyyy)
Sharon Noble	02/21/2018
Patient or Legal Representative Printed Name	**Relationship to Patient (if not Patient)**

0840-19 0CNT AUTH2N

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MAYO CLINIC

Authorization to Photograph or Video Record Patient

SCANNED

7-329-886 01/15/71 M 42
Severson, Mr. Sean T
1007 Fourth Street North
Stillwater MN
(781.94) Weakness Facial

(Mayo Clinic/Medical Record Number and Name Above)

Note: You do not need to add patient name, birth date, or record number if included on a label to the right.

Mayo Clinic/Medical Record Number	Birth Date
Patient Name	
Service/Procedure	

I consent to being photographed or video recorded by Mayo Clinic.

I consent to Mayo Clinic using the photographs or video recordings (collectively, the "Materials") for treatment purposes and for Mayo Clinic's internal health care operations, such as to improve quality of care to patients and to educate students and professionals at facilities staffed by Mayo Clinic. I also consent to Mayo Clinic using and disclosing the Materials for scientific, educational, and media-related purposes, provided my identity is not revealed.

I agree that the Materials shall be the sole and exclusive property of Mayo Clinic, free and clear of any claim on my part, and that I shall receive no royalties or other compensation or consideration for the Materials.

I release Mayo Clinic and its personnel from any and all liabilities which may arise from the use or disclosure of Materials and information under this authorization.

Note: ***The following four additional paragraphs apply only to Mayo Clinic's use and disclosure of Materials which reveal your identity (e.g., full-face photographs or other comparable images) for scientific and educational related purposes. If you do not wish to authorize the use and disclosure of such Materials for such purposes, you should line through these four paragraphs and/or initial this box [ ].***

I authorize Mayo Clinic to use and disclose Materials which reveal my identity for scientific and educational related purposes. I also authorize Mayo Clinic to use and disclose information about my medical care and treatment in connection with its use and disclosure of the Materials, including HIV/AIDS-related information and genetic testing-related information, if any such information exists. The disclosure of the Materials and information is authorized to the general public or medical, scientific or educational audiences via any method or media Mayo Clinic deems proper, including but not limited to continuing medical education conferences, lectures, presentations, and publications in professional journals, brochures, books, and magazines.

I understand that I may revoke this authorization at any time except to the extent that Mayo Clinic has already taken action in reliance on it. I understand that in order to revoke this authorization, I must do so in writing and present my written revocation to:

Mayo Clinic
Attention: Health Information Management Services
200 First Street SW
Rochester, Minnesota 55905

I understand that the revocation of this authorization will not apply to Materials and information that have already been disclosed in accordance with the terms of this authorization. I understand that this authorization will remain in effect unless specifically revoked by me.

I understand that Mayo Clinic will not condition treatment, payment, enrollment or eligibility for benefits on whether I sign this authorization.

I understand that, if Materials and information are disclosed to a third party, the Materials and information may no longer be protected by federal privacy regulations and may be re-disclosed by the person or entity that receives the Materials and information.

Signature of Patient or Legal Representative	**Mayo Clinic Use Only**
Date: 6-13-13	Unique
Relationship to Patient (if not Patient)	MC0640-19
	ODNT

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MAYO CLINIC

Patient Authorization for the Use and Disclosure of Photographs, Video Recordings, Audio Recordings, and/or Other Multi-Media Imaging

(complete fields or place patient label here)

Patient Name *(First, Middle, Last)* Ami N Overbeck	
Birth Date *(mm-dd-yyyy)* 06-06-1977	Room Number (if applicable)
Mayo Clinic Number	

TO BE SCANNED

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I consent to being photographed, video recorded, audio recorded, and/or to having other multi-media imaging taken of me (collectively, the "Materials") to be used by Mayo Clinic for identification, diagnosis, and treatment purposes.

Mayo Clinic may also use the Materials internally for the education and training of its staff and workforce, quality improvement, safety activities, and other healthcare operations. The Mayo Clinic Institutional Review Board may approve the use of the Materials for research.

I understand that whenever Materials are disclosed to a third party, they may no longer be protected by state and/or federal privacy regulations and may be re-disclosed by the recipient.

I understand that the Materials are Protected Health Information (PHI)* that may identify me. I understand that Mayo Clinic may take reasonable steps under federal law to remove information about my identity from the Materials. I understand that Materials that are de-identified in this way (collectively, "De-Identified Materials") are not PHI.

I agree that Mayo Clinic may use and disclose De-Identified Materials for educational purposes. Educational purposes include, but are not limited to, publication in professional journals, registries, brochures, textbooks, and/or their online equivalents as well as presentations at seminars, symposiums, and continuing medical education conferences. I understand that Mayo Clinic cannot guarantee that I will not be re-identified despite the steps taken to remove information about my identity.

If you **do not** want Mayo Clinic to use and disclose De-Identified Materials for educational purposes, please opt-out by checking the box below:

☐

I agree that Materials and De-Identified Materials are the sole and exclusive property of Mayo Clinic, free and clear of any claim by me, and I shall not receive royalties or other compensation or consideration for the use and/or disclosure of the Materials or De-Identified Materials by Mayo Clinic. I release Mayo Clinic and its personnel from any and all liabilities which may arise from the use or disclosure of Materials and De-Identified Materials under this authorization.

I understand that this authorization will remain in effect until Mayo Clinic fulfills all purposes for using and disclosing Materials and De-Identified Materials as described herein or until I revoke this authorization, whichever occurs sooner. I understand that I may revoke this authorization at any time except to the extent that Mayo Clinic has already acted in reliance on it. Revocation must be made in writing to: Mayo Clinic, Attention: Health Information Management Services, 200 First Street SW, Rochester, MN 55905.

I understand that the revocation of this authorization will not apply to Materials or De-Identified Materials that have already been disclosed in accordance with the terms of this authorization. I understand that this authorization will remain in effect unless specifically revoked by me.

I understand that Mayo Clinic will not condition treatment, payment, enrollment, or eligibility for benefits on whether I sign this authorization.

Attention: This is a legal document. Please read carefully. By signing, you agree that you understand and accept the terms on this form.

- **If the patient is 18 years of age or older,** the patient must sign and date the form.
- **If the patient is 18 years of age or older and is incapable of signing,** a legally authorized substitute may sign and date the form. Please indicate your legal authority and include documentation of your relationship:
  ☐ Legal Guardian or Conservator ☐ Health Care Agent (Health Care Power of Attorney)
- **If the patient is 17 years of age or younger,** the patient's parent or legal guardian must sign and date the form, unless an exception exists under state or federal law. Please indicate your relationship:
  ☐ Parent ☐ Legal Guardian

Signature (required) ▶ Ami Overbeck	Date (required) *(mm-dd-yyyy)* 01-10-2023
Printed Name of Person Signing (If not patient) *(First, Middle, Last)* Ami Overbeck	Relationship to Patient
Mailing Address *(Street, City, State, ZIP Code)* 1849 Red Ball Rd Rockford Ia 50468	Phone 641-430-0995
Email bige80@myomnitel.com	

*PHI includes, but is not limited to, information about my physical or mental health or my health care and any related psychological, psychiatric, sickle cell anemia, HIV/AIDS, communicable diseases, genetic testing, and alcohol or drug use diagnosis and treatment if such information exists.

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