

Comparative Analysis of Masseteric Nerve Graft versus Cross-facial nerve Graft for facial reanimation. A Systematic Review

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Systematic Review

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Abstract

Background:

Facial palsy (FP) is the standard surgical approach for restoring facial symmetry and dynamic facial movement in patients with facial nerve paralysis (FNP). Among the available nerve transfer techniques, masseteric nerve transfer (MNT) and cross-facial nerve graft (CFNG) are the most frequently used; however, their comparative effectiveness remains uncertain because of variations in functional recovery, spontaneity of smile, and patient-reported outcomes.

Objective:

To evaluate and compare the clinical effectiveness of MNT and CFNT in patients undergoing facial reanimation (FR).

Methods:

This review involved vigorous search in several electronic databases for studies evaluating MNT and CFNG in patients with FNP. Two reviewers independently performed study. Methodological quality was assessed using the ROBINS-I tool.

Results:

Following rigorous search and selection, 6 studies met the predefined criteria and were included. Overall, MNT demonstrated faster functional recovery and better facial symmetry, whereas CFNG showed superior spontaneous smile restoration.

Conclusions:

MNT provides faster reinnervation and superior early functional recovery, whereas CFNG offers greater potential for spontaneous facial expression. Both techniques are effective for FR, and procedure selection should be customised based on patient characteristics, duration of paralysis, reconstructive goals, and surgeon expertise. (Prospero reg no:CRD420251244569)

INTRODUCTION

Facial palsy (FP) is a neuromuscular ailment that imposes considerable burden, both functionally and aesthetically, as well as psychologically. Its devastating clinical manifestations include loss of oral competence resulting in drooling of saliva and speech difficulty, compromise of eye splinter muscle closure resulting in corneal ulcerations and blurred vision from impaired lacrimation and speech difficulty. [1] The condition has a multifactorial etiology originating from diverse causes such as trauma, infection, iatrogenic injury, idiopathic onset, or underlying pathological factors [2, 3]

Modern day facial reanimation (FR) needs to duplicate the facial symmetry, and dynamic facial expression. Surgical management of facial paralysis (FNP) is a strenuous task for a surgeon. [4] Nevertheless, the early stage of reconstruction supports salvaging neuromuscular junctions via nerves where facial fibrillations mimic musculature when the time of insult is less than 18 months. In contrast, long span FNP needs new neuromuscular units with local or free tissue transfer. [5, 6]

Various nerve transfer techniques—utilizing the hypoglossal, accessory, or phrenic nerves as donor motor sources, as well as cross-facial nerve grafting (CFNG)—have been attempted.[7] Traditionally, the hypoglossal or accessory nerve was selected to reinnervate the main facial nerve (FN) trunk when available. Although partial hypoglossal nerve transfer was previously favoured, sacrificing this donor nerve often results in hemiglossal atrophy, causing speech articulation difficulties, dysphagia, and substantial synkinesis. To mitigate these donor site morbidities, current protocols increasingly combine masseteric nerve transfer (MNT) with a CFNG.[8]

Management decisions are ultimately guided by the choice of the surgeon or based on their experience, alongside key patient factors. These include age, health status, underlying etiology, prognosis, and the duration of FNP. Additionally the viability of the ipsilateral FN, target facial musculature, and contralateral FN [9].

The masseteric nerve (MN), a motor branch of the trigeminal nerve's anterior division—serves as a primary alternative to hypoglossal nerve transfer in FR [9, 10]. Because of its high axon density, close proximity to the midface branches of the FN, and strong motor impulse, masseteric-to-FN anastomosis provides robust smile restoration [9, 10]. Furthermore, this transfer boasts low donor-site morbidity due to redundant masticatory function, rapid motor recovery, ease of central activation, and minimal neurotomy constraints [9, 10]. Consequently, it is a highly effective option for FNP, provided the patient is not scheduled for subsequent reconstructive surgeries [9, 10]

CFNG was first described in the 1970s and works by transmitting neural input from the healthy contralateral FN to the paralyzed side using an interposition nerve graft (commonly the sural nerve). Axonal regeneration across the graft occurs at ~ 1 mm/day, so functional reinnervation typically takes about 6–8 months or longer. Because of this delay, CFNG is often combined with a “babysitter” nerve transfer to preserve muscle viability during regeneration.[11, 12]

CFNG produces a true spontaneous, emotionally driven smile. However, it has limitations including lower axonal load, slower time to reinnervation, and less predictable outcomes. Results are generally less favorable in older patients due to reduced regenerative potential. CFNG typically produces more natural smile spontaneity but less commissure excursion compared with stronger motor nerve transfers. Contraction power is relatively weak and usually requires prolonged rehabilitation. Moderate smile excursion and optimal facial movement often take 12–24 months to achieve. [13]

Several studies have reported that the combination of CFNG and MNT to reanimate the midface in unilateral FP patients showed marked improvement with respect to resting facial symmetry and subsequently the smile. [14] Challenges in FR is to restore the spontaneous closure of eyes which is achieved through MN transfer. Selective MN transfer has also demonstrated better differential activation of the orbicularis oculi (OO) muscle compared with CFNG alone in patients who underwent combined procedures. [8] The aim of the present study is to compare the Effectiveness of MN and CFNG and in the management of FR.

MATERIAL AND METHODS

Protocol:

This study proceeded in adherence to the PRISMA guidelines and by registering in PROSPERO. (CRD420251244569).

Focused question:

“Is MNT better than CFNT in the management of FR.?” This was structured based on the PICOS as summarised in Table 1.

Table 1: PICOS of the present study

P	Population	Patients with FP
I	Intervention	MNT
C	Comparator	CFNG
O	Outcome	FaCE Scale Oral commissure movement smile excursion lip angle
S	Study design	Randomized controlled studies Non-randomized controlled studies

Information sources and Search strategy:

Literature search in several databases, was performed with pre-defined eligibility criteria and by employing a combination of keywords. The search strategy used to perform comprehensive literature search across all databases, ensuring the screening of all pertinent articles as described in supplementary table 1.

Eligibility criteria:

A. Inclusion criteria

1. Only original research with full-text availability and those published in English were included.
2. Comparative study design performed on adult patients (>18 years) with unilateral FP confirmed by House-Brackmann grade III-V and receiving MNT and Cross-FN graft were included.
3. Only studies evaluating and comparing the effectiveness of MNT and CFNG in the treatment of unilateral FP treatment.

B. Exclusion criteria

1. Systematic reviews, case reports, case series, and expert opinions.
2. Animal or in vitro studies.
3. Non-English or unavailable full-text articles.
4. Studies evaluating the pediatric cases, unconfirmed FP cases, other treatment modalities, nerve grafts other than MNT and CFNG

These criteria were established using the PICOS framework to ensure that only relevant, high-quality studies were included for analysis.

Study selection:

Research evaluating the effectiveness of MNT and CFNG in the treatment of unilateral FP treatment was systematically compiled by a comprehensive search of many electronic databases. Two reviewers individually assessed titles and further the abstracts to exclude irrelevant publications. The complete texts of possibly relevant studies were then assessed. Studies failing to meet the inclusion criteria, including those with unsuitable study designs, insufficient outcome data, or irrelevant interventions, were excluded. Discrepancies among the reviewers were addressed through dialogue or by seeking the opinion of a third reviewer to ensure uniformity and precision.

Data acquisition:

Two independent evaluators extracted data. The gathered data included study characteristics, participant details (sample size, diagnosis, age), specifics regarding the intervention, comparator, follow up and significant findings. Discrepancies encountered during data extraction were consulted with third reviewer.

Data Synthesis

Using a narrative approach the data was combined, however, no meta-analysis was performed due to inconsistent outcome measures, variable follow-up, and small/unreported sample sizes, precluding standardized mean differences or forest plots.

Risk of bias (ROB)

Two independent evaluators evaluated the methodological quality of the included studies by ROBINS I tool. Discrepancies encountered during data extraction were resolved through dialogue or by consulting a third.[15,16]

RESULTS

Literature search:

Through electronic databases 1936 articles were found while through manual search no articles were found. After duplicate removal 543 articles remained. Two reviewers independently screened titles/abstracts (n=543), excluding 484 irrelevant records. Full-text assessment of 59 articles was performed and further excluding 56 articles (Review articles [n=14], no direct comparison groups [n=5], case reports/series [n=9], Missing outcomes [n=11], studies evaluating other outcomes [n=11], and non-English/no full-text [n=5]). Finally, six studies met PICOS criteria. (Figure 1)

Figure 1; prisma flowchart presenting the study selection process

General characteristics of the included studies:

A total of 6 studies were included in the review. The characteristics of the included studies are summarised in table 2-5. All studies focused on dynamic reanimation techniques for chronic or post-tumor/trauma paralysis, using varied approaches like direct nerve transfers or free gracilis muscle flaps innervated by MNT or CFNG.

Table 2; Study Characteristics

S. No	Author	Country	Study Design	Patient Population	Sample Size (MNT / CFNG)	Etiology	Intervention (MNT)	Comparator (CFNG)
1	Coombs et al. (2009) [17]	USA	Retrospective comparative	Unilateral FP	NR	Tumor, trauma	MNT	CFNG
2	Biglioli et al. (2012) [18]	Italy	Prospective cohort	Long-standing FNP	NR	Tumor resection	MNT	CFNG
3	Banks et al. (2019) [19]	USA	Retrospective cohort	FP	NR	Tumor, idiopathic	MN innervation	CFNG
4	Hontanilla et al. (2018) [20]	Spain	Comparative observational	Chronic unilateral FP	NR	Tumor, trauma	MNT	CFNG
5	Sergesketter et al. (2023) [21]	USA	Comparative cohort	Post-tumor FNP	5 / 4	Tumor	MNT	Staged CFNG
6	Hontanilla et al. (2013) [22]	Spain	Prospective comparative study	Adults with long-standing (>2 years) complete unilateral FNP	27 / 20	Acoustic neuroma, posterior fossa tumors, trauma, congenital, iatrogenic	MN-innervated free gracilis muscle transfer	CFNG-innervated free gracilis muscle transfer

Table 3;. Facial Symmetry, Spontaneity, and Motor Control Outcomes

S. No	Author (Year)	Type of Reanimation	Symmetry / Motor Outcomes Assessed	Assessment Tool
1	Coombs et al. (2009) [17]	Direct nerve transfer	Facial symmetry at rest and smile	Clinical assessment
2	Biglioli et al. (2012) [18]	Free muscle transfer	Smile symmetry	Clinical grading
3	Banks et al. (2019) [19]	Gracilis FFMT	Smile spontaneity	Clinical observation
4	Hontanilla et al. (2018) [20]	Free muscle reanimation	Symmetry, coordination	FACIAL CLIMA
5	Sergesketter et al. (2023) [21]	Combined nerve reanimation	Synkinesis	eFACE
6	Hontanilla et al. (2013) [22]	Free functional gracilis muscle transfer and innervated by MNT vs CFNG	Smile symmetry, oral commissure displacement, contraction velocity, recovery percentage	FACIAL CLIMA (3D objective motion analysis)

Table 4; Patient-Reported Outcome Measures (PROMs)

S. No	Author (Year)	PROM Used	Outcome Domain	Follow-up
1	Coombs et al. (2009) [17]	Not reported	—	≥12 mo
2	Biglioli et al. (2012) [18]	Not reported	—	12–24 mo
3	Banks et al. (2019) [19]	FaCE Scale	Facial function / QoL	≥12 mo
4	Hontanilla et al. (2018) [20]	Not reported	—	18 mo
5	Sergesketter et al. (2023) [21]	FaCE Scale, eFACE	QoL, facial function	≥12 mo
6	Hontanilla et al. (2013) [22]	None reported	—	Mean 24 months

Risk of bias (ROB) assessment

ROBINS-I tool was utilised. [15,16] Overall, none of the included studies achieved a low overall ROB because all employed non-randomized observational designs. Three studies (Coombs et al., 2009 [17]; Hontanilla et al., 2013 [22]; Hontanilla et al., 2018 [20]; and Banks and team., 2019 [19]) were judged to have a serious ROB, primarily because treatment allocation was based on clinical judgment rather than randomization, leading to substantial risk of confounding and participant selection bias.

The remaining studies (Biglioli et al., 2012 [18] and Sergesketter et al., 2023 [21]) were considered to have a moderate overall ROB. These investigations reported clearly defined interventions and standardized outcome assessments but were still susceptible to confounding, selection bias, and the inherent limitations of retrospective or non-randomized study designs. Across all studies, the domains of intervention classification and deviations from intended interventions were generally rated as low ROB because the surgical procedures were well described and consistently implemented. Collectively, the available evidence should therefore be interpreted with caution, acknowledging the inherent limitations of observational FR studies. (Figure 2 and 3)

Figure 2; ROB assessment of the included studies using the ROBINS-I tool.

Figure 3; Summary of ROB assessment

DISCUSSION

FNP is a disabling condition usually associated with functional, aesthetic, and social consequences. It can worsen the quality of life in patients with congenital or acquired diseases. The paralysis of muscle leads to enormous functional deficiencies such as eye protections, speech and articulation defects, oral incompetence, and loss of facial expressions. The restoration of a dynamic smile is a crucial factor of FR.

Over the years, nerve-transfer techniques have developed to strengthen both functional and aesthetic outcomes. In 1903, the first FR surgery was conducted using hypoglossal nerve transfer. [23] FR techniques have been divided into neurotization procedures and free muscle transfers.[24] In 1978, Neurotization technique using masseter to FN transfer was achieved by Spira and associates, providing greater smile spontaneity than hypoglossal nerve transfer. [19, 18] In 1971, Scaramella et al described a Cross-FN grafts techniques for FP after tumor resection.[11]

Of the available strategies, MNT and CFNG have arisen as two of the most acceptable strategies for reinnervation of perioral muscle. Although CFNG has been considered the benchmark approach for achieving a rapid, emotionally driven smile by the contralateral FN. MNT has achieved improvement due to its robust axonal load, spontaneous reinnervation, one-stage approach, and reduced donor-site morbidity. Despite this, ongoing research is performed concerning their comparative effectiveness in providing efficient motor symmetry and patient-centered outcomes.[26]

All included studies were performed in various international centers showing different clinical protocols in FR. Coombs et al.[17] presented their outcome from Australia, Banks et al. (2019) [19] from the United States, Hontanilla (2013, 2018) [20, 22]

performed in Spain, and Sergesketter et al [21] from North America, while Biglioli et al. (2012) [18] were from Italy. These differences in geography can affect the timing, rehabilitation criteria, and patient selection, which leads to differences in final outcomes.

Of all included studies, adults with unilateral FNP received dynamic nerve-based FR, along with preserved distal mimetic musculature for appropriate neurotization. Banks et al. (2019) [19] focused mainly on patients with flaccid and post-paralysis. FP is managed with masseteric-to-facial (five-to-seven) transfer of nerves, whereas Coombs et al. (2009)[17] and Biglioli et al. (2012)[18] enrolled patients with disruption of the proximal FN, mainly after skull base surgery or long-standing Bell's palsy, and treated nerve anastomosis of masseteric-to-facial.

In these studies, MNT was the primary intervention, with CFNG reported as a standard option. Comparative research by Hontanilla (2013, 2018) [20, 22] and Sergesketter et al. [21] categorized patients managed with MNT versus CFNG, facilitating a straightforward assessment of functional and symmetry results. Overall, the samples were clinically parallel, comprising patients with confirmed FP receiving nerve transfer-related dynamic reanimation.

Objective movement outcomes

Movement outcome in the included studies mainly directed on excursion of oral commissure, regain of dynamic smile, symmetrical lip angle, and facial symmetry. Banks et al. (2019) [19] assessed excursion of commissure and noted a marked link between paralysis duration and postoperative smile excursion, along with reduced prolonged denervation. Biglioli et al. (2012) [18] showed facial symmetry restoration at rest and excellent results on dynamic smile, with motor recovery seen within 2–9 months postoperatively. Coombs et al. (2009) [17] explained refinement in tone and voluntary movement, while quantitative measures were not performed.

Comparative research showed similar patterns supporting MNT concerning initial motor recovery and excursion amplitude. Hontanilla (2013)[22] reported enhanced oral commissure movement and onset of contraction in patients treated with MNT compared with CFNG. This was corroborated by Hontanilla (2018) [20] who stated greater excursion amplitude and superior early motor activation in the MNT cohort. Sergesketter et al.[21] noticed stronger contraction and reliable smile excursion following masseteric neurotization. In all studies, reinnervation was achieved in MNT groups with shorter time duration. Conversely, CFNG needs a longer period of regeneration as it has two-stage designs.

Symmetry and Motor Outcomes Assessed

Symmetry at rest and while smiling was a main result in all included studies. Banks et al. (2019) [19] adopted physician-graded assessments with quality-of-life measures to assess motor recovery and perceived functional enhancement. Biglioli et al. (2012) [18] analyzed symmetry clinically and categorized results according to contraction degree and facial balance, while Coombs et al. (2009) [17] presented a refined assessment of motor improvement and tone. Whereas dynamic symmetry was enhanced in most patients after MNT, immediate emotional smiling was mostly restricted, while activation was usually reliant on mastication effort.

Moreover, comparative research detailed the variation in techniques. Hontanilla (2013) [22] stated optimized symmetry with both MNT and CFNG even though higher commissure displacement was seen in the MNT group. In another study, Hontanilla (2018) [20] assessed symmetry and noted that MNT provided stronger and more manageable excursions with CFNG, showing enhanced spontaneity in patients selectively. Sergesketter et al.[21] observed that masseteric-driven smiles need patients' education and cortical adaptation to adequate symmetry. Of all, MNT presents more anticipated and forceful excursion, while CFNG is planned to improve impulsiveness and emotionality in dynamic reanimation.

Assessment Tools

Various assessment tools were used in the studies, curbing the straight comparison between MNT and CFNG. Banks et al. (2019) [18] used standardized photographs, video analysis, objective commissure excursion measurements, and the validated FaCE scale to evaluate both functional and patient-reported outcomes. Biglioli et al. (2012) [18] leaned on clinical evaluation

associated with electromyography (EMG) to validate muscle viability and reinnervation, while Coombs et al. (2009) [17] commonly used qualitative clinical observation without standardized grading systems.

The studies by Hontanilla et al. (2013, 2018) [20, 22] evaluated the quantification of oral commissure displacement with facial grading scales to assess the symmetry and motor recovery. Sergesketter et al. [21] integrated clinician-based grading systems with objective movement analysis. Although methodological variability controls straight meta-analytic comparability, the common findings persistently assist the functional and MNT reliability in regaining dynamic smile excursion.

Follow-up

The duration of follow-up extended from 6 months in Banks et al. (2019) [19] and 12 months in Coombs et al. (2009) [17] and Biglioli et al. (2012) [18], with occasional long-spanned evaluations stated in a few studies. Other studies by Hontanilla (2013, 2018) [20, 22] and Sergesketter et al. [21] showed follow-up periods long enough to determine firm reinnervation, symmetry, and smile quality in certain time periods. Within the months of surgery, motor recovery started following MN, showing its shorter reinnervation distance and one-stage design. Longer follow-up established that although MNT presents accelerated motor activation, structured motor retraining is necessary to improve coordination and reduce synkinesis.

Limitations

The systematic review on MNT versus CFNG for FR has several methodological limitations that weaken its conclusions. Firstly, only six studies with small sample size were included. Secondly, there was a wide heterogeneity among the included studies regarding the sample populations, etiologies, methodology, and follow up duration. Thirdly, outcomes used varied tools (FaCE, eFACE, FACIAL CLIMA, clinical grading, EMG) without standardization, preventing meta-analysis.

CONCLUSION

The present systematic review exhibits that both MNT and CFNG are productive operative management in FNP patients requiring FR. Despite this, MNT invariably demonstrated initial onset of muscle contraction, rapid excursion, and highly accomplished results in symmetry at rest and while smiling. Its anticipated reinnervation pattern and reduced recovery period establish it as a stable option, especially in cases requiring rapid functional restoration.

In contrast, CFNG gives the benefits of rapid and emotionally driven smile reanimation, as it uses contralateral FN input. Although the recovery period is generally longer and the degree of muscle contraction may be comparatively less robust, CFNG stands worthwhile in patients, particularly in young people or those preferring rapid recovery. In some conditions, combining both techniques may further enhance functional and aesthetic results.

Altogether, the options between MNT and CFNG should be specific based on age, paralysis duration, muscular vascularity, aesthetics, and surgeon expertise. With current evidence strengthening the efficacy of both treatment options, further high-quality randomized controlled trials with standardized result values are crucial to support the relative evidence and clarify clinical decision-making in FR surgery.

Declarations

Author Contribution

Conception and Critical review- TB,CS; Manuscript writing: TB

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Figures

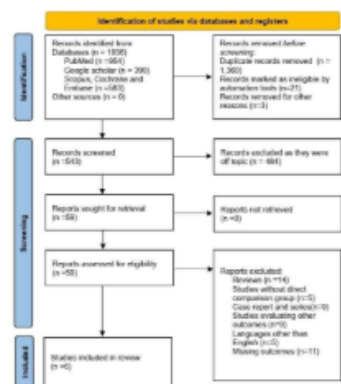


Figure 1

Prisma flowchart presenting the study selection process



Figure 2

ROB assessment of the included studies using the ROBINS-I tool.

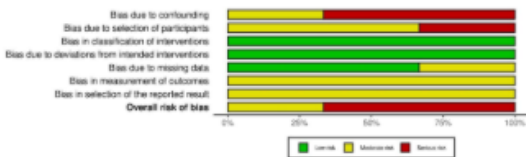


Figure 3

Summary of ROB assessment

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