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# Seminal Studies in Facial Reanimation Surgery: Consensus and Controversy in the Top 50 Most Cited Articles

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| **Abstract:** | Facial paralysis can impair one’s ability to form facial expressions that are congruent with internal emotion. This hinders communication and the cognitive processing of emotional experience. Facial reanimation surgery, which aims to restore full facial expressivity is a relatively recent undertaking which is still evolving. Due in large part to published techniques, refinements, and clinical outcomes in the scientific literature, consensus on best practice is gradually emerging, while controversies still exist. Taking stock of how the discipline reached its current state can help delineate areas of agreement and debate, and more clearly reveal a path forward. To do this, we have analyzed the 50 seminal publications pertaining to facial reanimation surgery. In longstanding cases, the free gracilis transfer emerges as a clear muscle of choice but the nerve selection remains controversial with prevailing philosophies advocating cross facial nerve grafts (with or without the support of an ipsilateral motor donor) or an ipsilateral motor donor only, of which the hypoglossal and nerve to masseter predominate. The alternative orthodoxy has refined the approach popularized by Gillies in 1934 and does not require the deployment of microsurgical principles. While this citation analysis does not tell the whole story, surgeons with an interest in facial reanimation will find that this is a good place to start. |

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25th February 2021

Dear Dr. Habal,

I hereby submit my article entitled **"Seminal Studies in Facial Reanimation Surgery: Consensus and Controversies in the Top 50 Most Cited Articles"** for consideration of publication in the journal.

Facial reanimation surgery is a relatively young sub-specialty which is still evolving. Largely through trial and error, the best practices are beginning to emerge but controversies still exist and are the subject of fierce debate in international forums dedicated to the subject. Over the past few years a number of authors have sought to take stock of where we are now by evaluating the top 50 most cited articles in subjects ranging from facial rejuvenation to hand surgery and this has been a useful exercise in establishing areas of consensus and controversy. We have sought to do the same for facial reanimation surgery, curating the top 50 most cited articles and drawing conclusions about where we are now and where we are going.

It has not been published elsewhere nor is it under consideration in another journal. If accepted, it will not be published elsewhere.

I thank you for your time in reviewing my article and hope that you find it suitable.

Yours sincerely,

Dr. Graeme E. Glass PhD, FRCS(Plast)

# Seminal Studies in Facial Reanimation Surgery:

# Consensus and Controversies in the Top 50 Most Cited Articles

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**Abstract:**

Facial paralysis can impair one's ability to form facial expressions that are congruent with internal emotion. This hinders communication and the cognitive processing of emotional experience. Facial reanimation surgery, which aims to restore full facial expressivity is a relatively recent undertaking which is still evolving. Due in large part to published techniques, refinements, and clinical outcomes in the scientific literature, consensus on best practice is gradually emerging, while controversies still exist. Taking stock of how the discipline reached its current state can help delineate areas of agreement and debate, and more clearly reveal a path forward. To do this, we have analyzed the 50 seminal publications pertaining to facial reanimation surgery. In longstanding cases, the free gracilis transfer emerges as a clear muscle of choice but the nerve selection remains controversial with prevailing philosophies advocating cross facial nerve grafts (with or without the support of an ipsilateral motor donor) or an ipsilateral motor donor only, of which the hypoglossal and nerve to masseter predominate. The alternative orthodoxy has refined the approach popularized by Gillies in 1934 and does not require the deployment of microsurgical principles. While this citation analysis does not tell the whole story, surgeons with an interest in facial reanimation will find that this is a good place to start.

**Introduction:**

Facial paralysis is a devastating condition that may impair one's ability to form facial expressions that are congruent with internal emotion thus adversely affecting communication, social interaction, and self-esteem.[1-3] According to the facial feedback hypothesis, the inability to express emotion through facial expression attenuates the emotional experience itself, and influences cognitive processing of the experience.[4,5] Moreover, inability to move the muscles of the face purposefully has functional consequences for speech, mastication, deglutition and eye protection.[6] Conversely, restoration of emotionally congruent facial expression has been shown to improve self-esteem and quality of life subjectively, although objective outcome measures are lacking.[7]

Many different approaches to surgical restoration of the absent smile have been described, and the path toward clinical progress has been predictably convoluted. Among the most notable early contributions include the report by Anderl [8], in 1973, of the use of cross facial (sural) nerve grafts (CFNG) from branches of the contralateral facial nerve to corresponding branches on the affected side for direct facial reanimation. These procedures were performed in two stages and the results were inconsistent, probably on account of the wide variations in the latency and thus contractile potential of the muscle targets.[8] To address the unresponsiveness of the autologous facial musculature after prolonged denervation, Harii and colleagues, in 1976, first reported the use of the microvascular free gracilis muscle transfer for facial reanimation.[9] In this case, the deep temporal nerve was used as the motor nerve donor. In 1980, O'Brien and colleagues[10], combining these concepts, first described the use of the CFNG in tandem with a microvascular free muscle

transfer (a case series in which both the gracilis muscle and the extensor digitorum brevis muscle were used). This approach (employing a microvascular free gracilis muscle transfer innervated by a pre-neurotized cross facial nerve graft) became the foremost surgical technique for smile restoration over the next 25 years.

It was recognized by some, however, that there were limitations to the CFNG including prolonged neurotization time and a weak signal and ipsilateral motor donors were revisited as alternatives, either in their own right or as a means of augmenting the neural signal and preserving the contractile potential of the autologous musculature while awaiting neurotization of the CFNG. These motor donors included the hypoglossal nerve [11] and the nerve to masseter, a motor branch of the trigeminal nerve.[12] Others went further, using the nerve to masseter to innervate a free muscle transfer[13] or using the nerve to masseter to facial nerve transfer for direct, one stage facial reanimation.[14,15] Recent anatomic studies have revealed several advantages of the nerve to masseter a source or neural input.[16]

Concurrently, an alternative orthodoxy also gained momentum. This approach, an evolution of a traditional approach popularized by Gillies in his landmark paper of 1934[17] used the temporalis as an ipsilateral muscle and/or fascial sling. This approach has undergone a number of refinements and variations by surgeons including McLaughlin (1953)[18], Rubin (1974)[19], May & Drucker[20], Byrne et al[21], Labbé & Huault[22] and, most recently, by Park et al (2020).[23] A number of ancillary procedures have been developed to complement the central focus on smile restoration, including the management of (nocturnal) lagopthalmos using a combination of a

Gold weight or similar to the upper eyelid and lateral canthopexy. A second free muscle transfer using platysma for eye closure has also been described.[24] Symmetrization of the lower lip has been achieved using botulinum toxin or selective myotomy of the contralateral side, and even muscle transfers to the ipsilateral side, for example the anterior belly of the digastric.[11]

Taking stock of how the field of facial reanimation reached its current state can help delineate areas of agreement and debate, and more clearly reveal a path forward. To do this, we have curated and analyzed the 50 most-cited articles pertaining to facial reanimation surgery. This paper serves as a single point of reference for plastic surgeons interested in the evolution of facial reanimation surgery and the attendant rationale for contemporary approaches. [25-32]

**Methods:**

***Article selection***

The Web of Science was queried to identify the most cited articles in the field of facial reanimation surgery from 1864-2020. The search was performed in February/March and again in October/November of 2020 and utilized all databases available at the Web of Science. Search terms included “smile”, “facial”, “face”, “lip”, “reanimation”, “restoration”, “musc* reconstruction”, “musc* transplant*”, “musc* transfer”, “musc* graft”, “nerve reconstruction”, “nerve transfer”, “nerve graft”, “nerve transplant*”, “nerve coaptation”, “nerve co-aptation” and “neuromusc* reconstruction”. The search was not restricted by language or date of

publication. A detailed summary of how this search strategy can be found in supplemental material.

***Data extraction***

Following completion of the search, a list was compiled of the top 500 most cited articles identified (see supplementary data). Beginning with the most cited, each article was, in turn, screened for their relevance to facial reanimation surgery by two authors (T.B. and M.A.) and discrepancies resolved following repetition by the senior author (G.G.). Purely anatomic or preclinical experimental studies were excluded, as were clinical studies that did not report explicitly on facial reanimation surgery. Review articles were also excluded on the basis of potential duplication of original data. This task was completed when the 50 most cited relevant original articles were identified. The following basic data was extracted from the identified articles: authors, journal and year of publication, country and institution of corresponding author and level of evidence. Information related to facial reanimation was also extracted. Data extraction was performed by two authors (T.B. and A.M.). In order to counter citation bias (the phenomenon whereby older articles have a higher number of citations merely on account of a longer citable period), a citation index was calculated for each.

**Results**:

The initial search returned a total of 3048 articles. Of these, the 500 most cited articles were selected and the title and abstract and, if necessary, the full texts were scrutinized to establish relevance. This process was conducted sequentially, beginning with the most cited. Once the

50th relevant article was identified, the process was stopped and the definitive list curated. The 50 most cited articles in facial reanimation surgery are summarized in Supplemental Table 1. The 50 most-cited articles were published between 1973 and 2015. The mean number of citations per article was 104.72 (± 62, 1 S.D. (one standard deviation)). The range of citations from the most cited to the 50th most cited was 464 to 64. The mean citation index was 5.64 ± 3.18, 1 S.D. The total sum of all citations in the 50 articles was 5236 citations, or 5099 excluding self-citations. This is shown in Supplemental figure 1. The geographic distribution of the contributing institutions is shown in Supplementary Table 1. The corresponding institutional affiliations are shown in Supplementary Table 2. To evaluate the endurance of these seminal papers over time, a Spearman correlation was used to evaluate the number of citations per year against the number of years since publication (correlation = -0.73). This is shown in Figure 1.

In terms of the subject matter of the included studies, all were clinical studies. Clinical studies were classified according to their level of evidence, demonstrated by study type in Figure 2. Among the articles amenable to grading level of evidence (n= 44), most (n=28) were level IV evidence. The other articles were classified as level III (n=5) and level V (n=11).

Articles discussing outcomes (n=19) and comparisons of outcomes between different techniques (n=6) were most common, followed by new techniques and innovation (n=18), and grading/quantification of outcomes (n=7). This is shown in Figure 3. The muscle used to reanimate the face was discussed in 27 of the 50 studies. The most common muscle used to

restore facial animation was the gracilis (n=16), followed by temporalis (n=6), latissimus dorsi (n=7), pectoralis minor (n=3), serratus anterior (n=1), and rectus femoris (n=1). These are represented in Figure 4. Some papers discussed more than one source of muscle (n=12). The nerve used to reanimate the face was discussed in 39 of the 50 studies, and are shown in Figure 5. The nerve donor most commonly used to restore facial animation was the CFNG (n=16) and the hypoglossal nerve (n=16). In some studies, the hypoglossal donor was described in combination with a CFNG. The CFNG was also described in combination with an ipsilateral facial nerve or accessory nerve co-aptation. The nerve to masseter was the next most cited (n=7). Single studies reported use of the deep temporal nerve and a direct co-aptation from the contralateral side.

**Discussion:**

The contemporary surgical approach to facial reanimation is the distillation of around 50 years-worth of peer-reviewed studies exploring different surgical strategies and protocols, investigative modalities, rehabilitation algorithms and outcome analyses. This study, a citation analysis, reveals the most cited articles in the field. If we accept that citations are, broadly speaking, representative of attributable peer value, the citation analysis gives us an interesting perspective on the evolution of facial reanimation surgery and the areas of consensus. Furthermore, it allows us to speculate over the existing areas of controversy and to draw conclusions about where we might be heading as we seek further refinements and consensus in our approach.

***Historical perspectives***

The birth of modern facial reanimation surgery can admissibly be attributed Anderl who, in 1973 first described the CFNG for neurotization of the autologous facial musculature in 5 patients[8] and to Harii and colleagues who, in 1976[9] first described the use of a microvascular free muscle transfer for the restoration of smile in 2 patients with long standing facial nerve palsy. Contemporaneously, O'Brien and colleagues applied the best principles of both studies, publishing a series of 20 patients who underwent reconstruction of long standing facial palsy in 1980.[10] It comes as no surprise therefore that these papers are among the most cited articles in the field. This, however, only tells part of the story. The strength of any scientific enquiry lies with the fact that it is defensible. The inherent drawback of a citation analysis is that both the corroborative and contradictory work that serves as the basis for that defense is omitted from the narrative. For example, the work of Anderl was contemporaneous with that of both Smith and Scaramella, who, independent of each other, described CFNG in 1971.[33,34] Thompson, again in 1971, described the use of skeletal muscle grafts (devascularized strips of skeletal muscle).[35] In 1975, Freilinger, interested in both the concepts of CFNG and the use of free muscle grafts described attempts to neurotize a free muscle graft using a CFNG in a patient with long standing facial palsy.[36] In the other case in Feilinger's series of two, a central, turned down strip of temporalis was innervated using a CFNG. In both cases the nerve was implanted directly into the muscle.

In response to the failure of earlier attempts to neurotize devascularized muscle grafts using CFNG, the utilization of fledgling microsurgical techniques to produce a vascularized muscle flap

innervated by a CFNG represented a paradigm shift in facial reanimation surgery, opening up new possibilities that, within a short space of time, had dramatically enhanced the repertoire of reproducible two-stage surgical options. That the first microvascular free muscle transfer should be the gracilis muscle which, over 40 years later is still the most commonly performed microvascular free muscle transfer for facial palsy is surprising but we can observe, through the work of O'Brien et al and Mayou et al independently (extensor digitorum brevis)[37,38], Harrison and Terzis independently (pectoris minor)[39,40], Harii again (latissimus dorsi)[41], Hata and Koshima (rectus abdomnis)[42] and Buncke(serratus anterior)[43] that the primacy of the gracilis muscle as a donor for facial reanimation did not go unchallenged. To variable degrees, these additional options are still used as per surgical preference.

More recently, the popularization of one-stage approaches using ipsilateral motor nerve donors is actually closer conceptually to Harii's seminal work of 1976 than the two-stage approach using a CFNG that succeeded it. Of these, the hypoglossal nerve is most commonly cited among the seminal papers. The first hypoglossal-facial transfer was described by Korte[44] in 1902, but led to significant tongue atrophy. In modern practice, a number of cases series and modifications have been described. Both Conley & Baker (1979)[45] and Gavron & Clemis (1984)[46] repopularized the direct hypoglossal to facial nerve co-aptation for ipsilateral facial palsy. To preserve hypoglossal nerve continuity and thus tongue tone and bulk, Sawamura and Abe used a side to end co-aptation.[47] while both May et al[48] and Terzis et al[11] split the hypoglossal nerve longitudinally. Additionally, May et al used a bridging nerve graft as they found the partial nerve graft was less mobile. More recently, the nerve to masseter has found

favor. It is an axonally dense nerve that provides an excellent motor signal with minimal morbidity and can, with therapy, yield a spontaneous smile in most cases.[13,49] These options are popular not merely for direct facial nerve transfers in subacute facial nerve paralysis but also for the innervation of free muscle transfer in a one stage approach for long standing facial palsy (Manktelow).[50]

***Alternative orthodoxies***

While nerve transfers and free muscle flaps brought the techniques of microsurgery to bear on facial palsy, there were others who continued to develop and refine the traditional approach using the ipsilateral temporalis popularized by Gillies in 1934. The most frequently cited adaption of Gillies approach is the lengthening temporalis myoplasty described by Labbé and Huault.[22] The original paper was a case series of 10 patients and the technique was a variation on McLaughlin's modification of Gillies method.[18] A larger case series was subsequently published.[51] It deviated from the prevailing trend by requiring neither microvascular free tissue transfers, nerve transfers nor grafts. Modifications of this variation have since been described by others.[21,23,52]

***Where the consensus lies***

The seminal papers reveal that there is consensus that longstanding facial palsy requires fresh muscle, that muscle grafts are not a good idea[53], that subacute, non-resolving facial palsy is best managed by a nerve transfer[54] and that the motor input of choice in all cases lies between the contralateral buccal plexus and an ipsilateral motor donor of which the hypoglossal and masseter nerves are the most popular.[14,55] In the literature considered here, we found much

support, if not a clear consensus, for the microvascular free gracilis transfer as the muscle of choice in long standing facial palsy.[56,57] There is a consensus that objective outcome measures are required to drive improvements in the quality of the literature and enable us to make better decisions.[58,59]

***Ongoing controversies***

One of the key areas of controversy is the nerve used to reanimate the face. In essence, the consensus has been divided into those who favor a cross facial nerve graft and those who favor an ipsilateral motor donor. At the heart of the argument is the relative importance of spontaneity of smile and ease of rehabilitation over strength and predictability of neural signal and speed of re-nervation.[16,60,61] The argument is complex and nuanced. Following denervation of skeletal muscle, the motor end plates begin to deteriorate and the potential for meaningful contraction is irreversibly lost by about 12-15 months.[11,62] Accepting that the best muscles to make a smile are the ones that nature intended, facial palsy of less than 9 to 12 months duration can best be managed with a direct nerve transfer while smile restoration in long standing facial palsy requires a free muscle transfer. Whether providing a neural stimulus to the autologous musculature or a free muscle flap, advocates of the CFNG assert that smile spontaneity is superior[54,63] and, in the case of long standing facial palsy, worth the extra stage as the CFNG is neurotized prior to muscle transfer to minimize denervation time. The counter argument avows that an ipsilateral motor donor, especially the nerve to masseter[13,14,64] or the hypoglossal nerve[47,62,65-69] are better options because these motor donors are more axonally dense and as the regenerating axons merely have to traverse one rather than two co-aptations, the strength of the neural signal arising at the motor end plates is superior[16] and this translates

to enhanced muscle excursion and more predictable results relative to the CFNG.[60,70,71] Furthermore, recovery is faster and, with the correct motor donor, an initial volitional smile may achieve spontaneity in a high proportion of cases.[13,60,72] The argument is sometimes framed as a choice between the relative merits of a one stage versus two stage approach. The alternative one stage option in long standing facial palsy is to avoid both a CFNG and an ipsilateral motor donor by harvesting a muscle flap with a long motor nerve (latissimus dorsi, rectus femoris) and coapting the nerve directly to the contralateral buccal plexus. The rationale for this approach is that it offers the benefits of a CFNG in terms of smile spontaneity without the drawbacks of a two stage reconstruction and the diminution of neural signal across two nerve coaptations.[42] The major shortcomings of this method include prolonged muscle inertia and donor site morbidity. A free muscle transfer, innervated by a CFNG performed at the same time as has also been described.[73]

When it comes to re-nervation of the autologous facial musculature, time is of the essence. While ipsilateral motor donors neurotize muscle targets relatively quickly, proponents of the CFNG manage prolonged muscle latency by supplementing the CFNG with an ipsilateral motor donor. The "babysitter" solution, first reported by Terzis in 1984[62] and later expanded upon in her 75 patient follow up in 2009 [11] used the partial hypoglossal to facial nerve transfer as an end-to-side co-aptation. The nerve to masseter has also been used as a "babysitter".[74] In the 32 landmark studies that discussed the topic, the use of the use of ipsilateral motor donors was the favored option in 12 and the CFNG was favored in 6. The remaining 14 described a combination of options

Another important area of controversy, inferred by examination of the pivotal studies, is the lack of agreement in the means by which outcomes may be assessed. As the citation analysis and a broader perusal of the literature demonstrates, there is no consensus yet as to how this might be addressed.

***Limitations***

The mean number of citations per article presented in our study is 104, comparable with the numbers cited in previous plastic surgery seminal article reviews.[25-31,75,76] Most articles discussed either outcome (n=19) or comparison of outcomes n=6, and novel or elaborated techniques (n=18). Based on level of evidence criteria [62], 28 studies were level IV, 11 studies are level V (case reports) and 5 studies are level III (case-control/comparison). Some studies were not amenable to level of evidence grading as they focused on grading scale/classification and quantification of outcomes (n=6). Higher levels of evidence will require carefully designed multi-institutional collaborations.[77]

Care must be taken when interpreting an analysis based on maximal number of citations as a means of highlighting technical evolution and guiding best practice. It may only tell part of the story. It could be argued that the selection of these papers is part of a process of incremental confirmation bias that has helped them to become the most cited articles in the field. Moreover, pre-eminence in the field predictably results in a greater number of citations and makes self-citations more impactful. There are a total of 4 major groups represented in the 50

papers including Harii, Terzis, Zuker, and Hadlock groups who are presented a total of 16 times between them. It would be naive to think that the personalities, rivalries and specialty backgrounds of the main protagonists did not influence the evolution of the discipline of facial reanimation.

***Future directions – towards a data-driven consensus***

Ultimately, the clinical approaches employed in the field of facial reanimation must be scientifically defensible. Slowly but surely, clinical research is becoming more scientific and past collective failures which owed much to the power of personality and peer politics will fade into history. One crucial obstacle that is well on its way to being overcome is the issue of the objectiveness of outcome measures. Several groups have been working on this and options include linear morphometric data.[78,79] Alternatively, our group has been working on using artificial intelligence to quantify smile before and after facial reanimation surgery by comparing the subject against thousands of control subjects.[80] This, in our view, is particularly attractive as, by obtaining objectively derived, ordinal data before and after surgery we can quantify the restoration of a natural smile; that ethereal phenomenon that defies reduction to a sum of vectors and excursions. This is, after all, the final arbiter of surgical success. Additionally, the use of patient reported outcome measures (PROMs) has permitted better objective comparisons among techniques from a patients perspective. Together these new tools offer the prospect of a data-driven consensus. Importantly, for the foreseeable future there will be ample scope for innovation in facial reanimation surgery. In amassing the tools needed to

objectively evaluate our innovations, we may find ourselves, like our senior colleagues did in the 1970's and 1980's on the cusp of a new era in facial reanimation surgery.

**Conclusion:**

An analysis of the 50 most cited original articles in facial reanimation surgery illuminates the major concepts of both the past and present. The gracilis muscle emerges as a clear muscle of choice in longstanding cases, while controversy still exists in term of the best nerve selection in both subacute (not requiring a muscle flap) and longstanding cases. Two prevailing philosophies exist. Proponents of the cross facial nerve graft cite evidence that this approach provides the best chance of a spontaneous smile. The alternative viewpoint avows that the signal is weak and muscle excursion limited using this approach and instead favor ipsilateral motor donors providing faster neurotization and greater facial landmark excursion owing to a stronger signal. The alternative orthodoxy has refined the approach popularized by Gillies and does not employ microsurgical principles. While this citation analysis does not tell the whole story, surgeons with an interest in facial reanimation will find that this is a good place to start.

**Conflict of Interest Statement:**

The authors have no conflicts of interest to declare or financial interest to declare in relation to the content of this article.

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**Figure Legends:**

Supplemental Table 1: A summary of the 50 most cited articles in the field of reanimation from 1976-present.
Supplementary table 1: Country of origin of the 50 seminal papers.
Supplementary table 2: Number of citations per institution of the 50 seminal papers.
Figure 1: Number of citations per year against the number of years since publication (correlation
= -0.73).
Supplemental figure 1: Number of studies meeting the inclusion criteria published annually from 1970 to 2019.
Figure 2: Clinical studies classified according to their level of evidence, exhibited by study type.
Figure 3: Number of articles per decade discussing outcomes and comparisons of outcomes between different techniques.
Figure 4: The most common muscles used to restore facial animation.
Figure 5: The variety of nerves used in different decades to reanimate the face.

Supplemental Figure 1

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Figure 1 (1 Figure per File. DO NOT embed image in TEXT)

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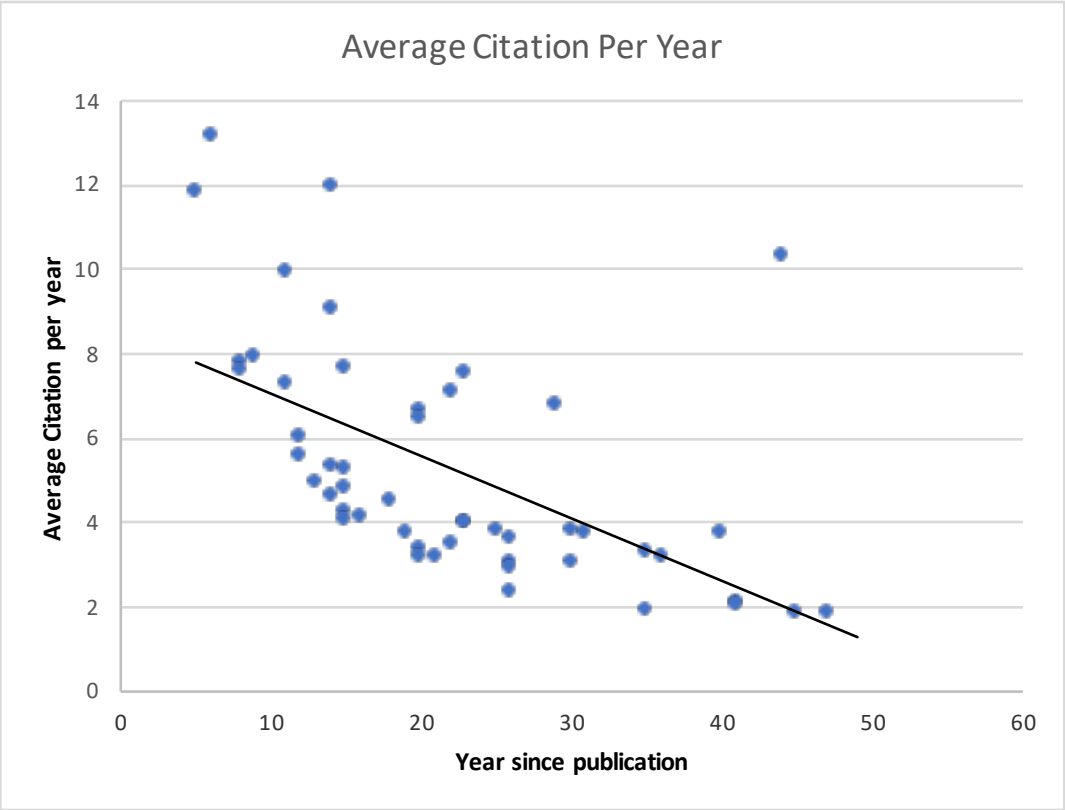

Figure 2

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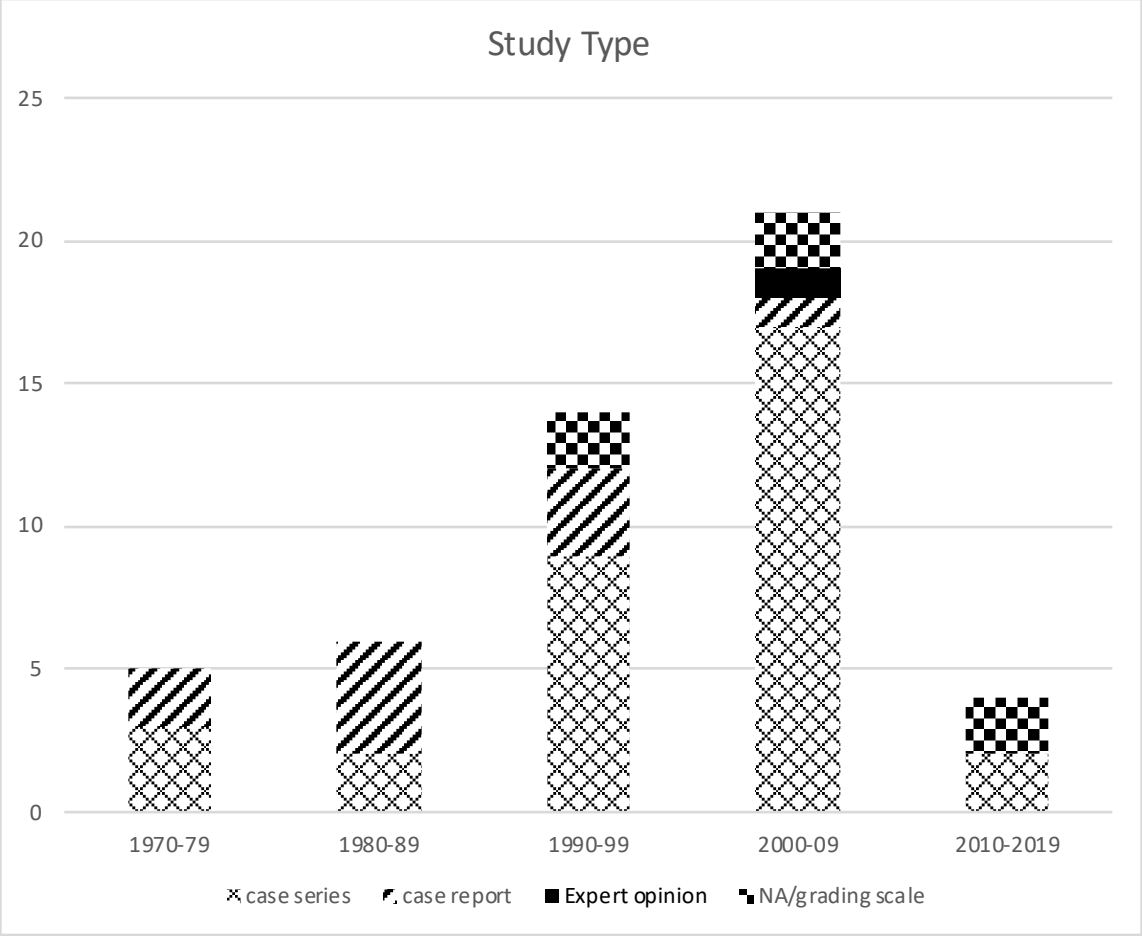

Figure 3

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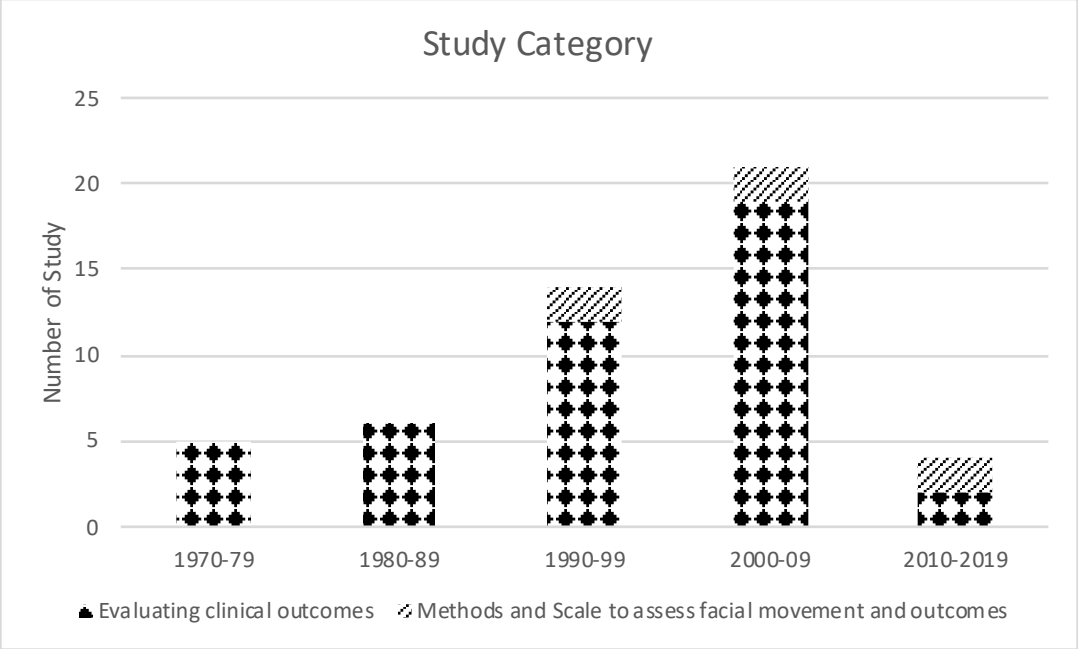

Figure 4

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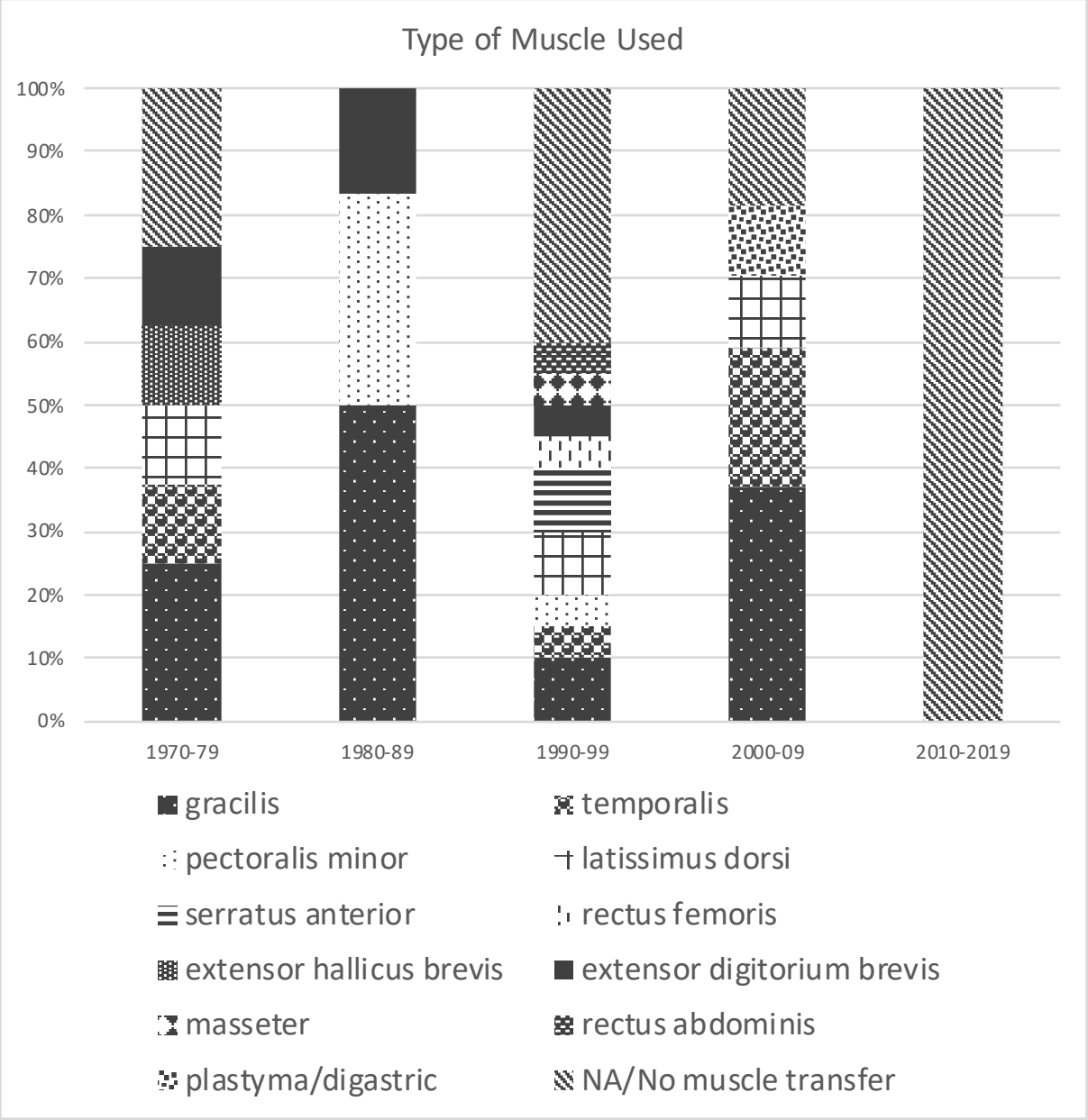

Figure 5

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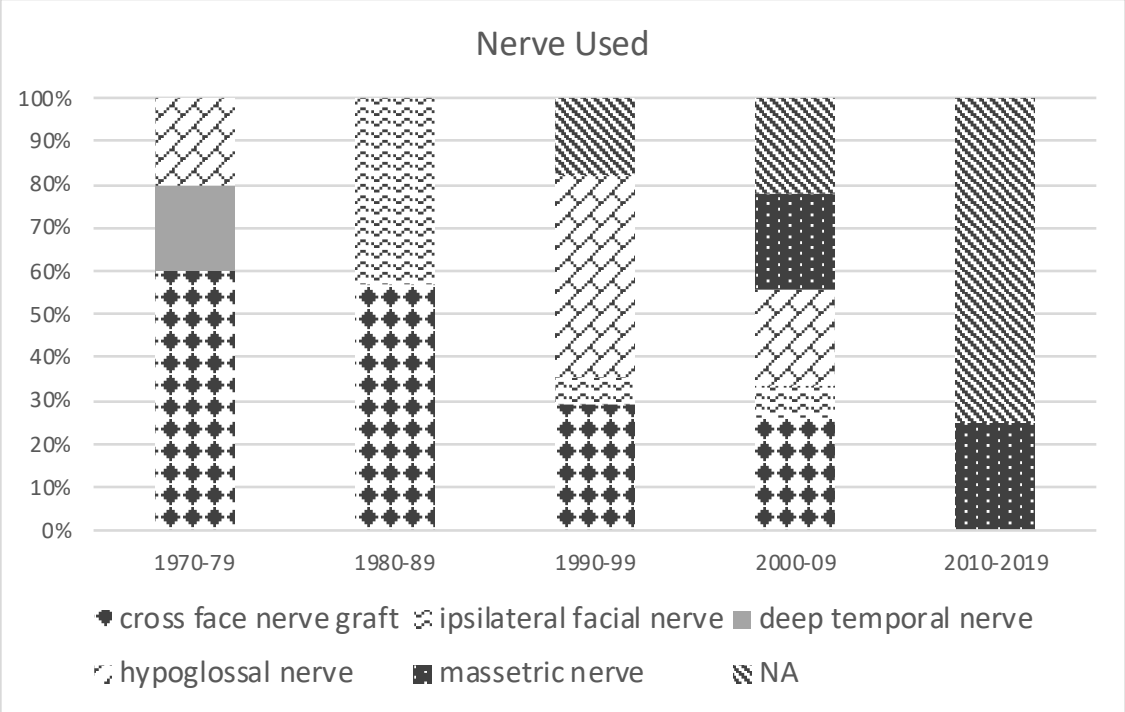

**Supplemental Table 1**

| Ref | Rank | Number of Citations | Author | Year | Journal | Title | Summary |
|---|---|---|---|---|---|---|---|
| | 1. | 464 | Harii K et al | 1976 | Plastic & Reconstructive Surgery | Free gracilis muscle transplantation, with microneurovascular anastomoses for treatment of facial paralysis - preliminary-report | Two cases of free transfer of the gracilis muscle for dynamic reconstruction of facial paralysis described. This is the first report utilizing the gracilis muscle.<br><br>Follow-up study with electromyography, light microscopy, and electron microscopy. |
| | 2. | 204 | May M et al | 1991 | Otolaryngology-Head and Neck | Hypoglossal-facial nerve interpositional-jump graft for facial reanimation without tongue atrophy | Report on the indication and results of the hypoglossal-facial nerve interpositional jump graft procedures for facial reanimation in selected patients. Thirteen patients (two treated for bilateral facial paralysis) having excellent, and three superb, recovery of facial movement. |
| | 3. | 181 | Terzis JK & Noah ME | 1997 | Plastic & Reconstructive Surgery | Analysis of 100 cases of free-muscle transplantation for facial paralysis | Reporting on clinical outcomes of one surgeon using gracilis, pectoralis minor and latissimus dorsi muscle transplantation for reanimation.<br>Onset of muscle function was 21 weeks after transplantation.<br>80 percent of all patients achieved a moderate or better result. |
| | 4. | 179 | Manktelow, RT | 2006 | Plastic & Reconstructive Surgery | Smile reconstruction in adults with free | Investigates the outcome of masseter motor nerve-innervated gracilis in unilateral or bilateral facial paralysis, using a one stage procedure. |

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| | | | | | muscle transfer innervated by the masseter motor nerve: Effectiveness and cerebral adaptation | Spontaneous smile without thinking occur routinely in 59% of their patients (age range 16-61 years). Age did not affect the degree of spontaneity of smile. |
| 5. | 163 | Harii, K | 1998 | Plastic & Reconstructive Surgery | One-stage transfer of the latissimus dorsi muscle for reanimation of a paralyzed face: A new alternative | Presentation of 24 patients who underwent one stage latissimus dorsi transfer for reanimation. 21 patients (more than 87 percent) believed that their results were excellent or satisfactory, which also compares well with the results of the two-stage method combining free-muscle transfer with cross-face nerve graft. |
| 6. | 154 | Obrien, BM | 1980 | British Journal of Plastic Surgery | Cross-facial nerve grafts and microneurovascular free muscle transfer for long established facial palsy | Cross-facial nerve grafts followed in 4 to 12 months by microneurovascular free gracilis transplantation can produce adequate reconstruction in the lower two-thirds of a paralyzed face. Mixed sensory and motor deep peroneal nerve and the small muscle bulk of the extensor digitorum brevis limit its usefulness in facial palsy. The gracilis has proved to be a much superior muscle. A feasible method for total reanimation of unilateral facial palsy is presented. |

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| 7. | 139 | Zuker, RM | 2000 | Plastic and Reconstructive Surgery | Facial animation in children with Mobius syndrome after segmental gracilis muscle transplant | Assessment of outcome in 10 patients with Mobius syndrome who underwent reanimation using gracilis muscle with masseter nerve. All achieved reinnervation and significant improvement in functional outcomes. Discussion of surgical techniques is outlined in detail. |
| 8. | 136 | Bae, YC | 2006 | Plastic & Reconstructive Surgery | 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 | Case series comparing gracilis muscle innervated with cross face nerve graft, ipsilateral masseteric nerve, and ipsilateral accessory nerve. Their results indicate that segmental gracilis muscle transplantation using the motor nerve to the masseter nerve for facial animation in children is a very reproducible operation and provides a commissure excursion in the range of normal. |
| 9. | 136 | Labbe, D | 2000 | Plastic & Reconstructive Surgery | Lengthening temporalis myoplasty and lip reanimation | Report on using temporalis muscle for lip reanimation in 10 patients, which was a new novel technique. The author report satisfactory outcomes with 4 year follow up. |
| 10. | 122 | Coulson, SE | 2005 | Otolaryngology-Head and Neck | Reliability of the Sydney, Sunnybrook, and House Brackmann facial grading systems to assess voluntary | Clinical grading of voluntary movement revealed good correlation between ratings given on the Sydney and Sunnybrook systems, and good reliability within each. The assessment of synkinesis was far less reliable within and less related between systems. Although the House Brackmann system's reliability was high, |

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| | | | | | movement and synkinesis after facial nerve paralysis | individual grades revealed some wide variation between trained observers. |
| 11. | 119 | Terzis, JK | 2009 | Plastic and Reconstructive Surgery | The Babysitter Procedure: Minihypoglossal to Facial Nerve Transfer and Cross-Facial Nerve Grafting | The original babysitter procedure offers significant improvement in selected patients with facial paralysis. Symmetry and coordinated movements can be restored, with satisfying aesthetic and functional outcomes. |
| 12. | 119 | Terzis, JK | 1989 | Plastic and Reconstructive Surgery | Pectoralis minor - a unique muscle for correction of facial palsy | The detailed operative approach for the pectoralis minor transfer is presented, along with strategies for insetting this muscle unit in the new recipient site. The clinical case highlighted demonstrates the dual nerve supply and the resulting independent eye and smile movements with a total lack of mass action and/or synkinesis. Restorations of eye blink and a symmetrical and coordinated smile are the benefits of using this muscle to correct facial palsy. |
| 13. | 118 | Obrien, BM | 1990 | Plastic and Reconstructive Surgery | Results of management of facial palsy with microvascular free-muscle transfer | The overall final result was excellent or good in 51 percent of 47 patients available for follow-up, signifying the gracilis muscles reliability in free transfer. Cranial nerve seven was utilized in the muscle's innervation, preferably the ipsilateral if available. The authors believe that using the |

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| | | | | | | same cranial nerve is superior to methods involving other cranial nerves. |
| 14. | 118 | Harrison, DH | 1985 | Plastic and Reconstructive Surgery | The pectoralis minor vascularized muscle graft for the treatment of unilateral facial palsy | Report on 10 pectoralis minor transfer. The first stage constitutes a nerve graft from the functional contralateral facial nerve to the paralyzed side's preauricular region. Six months later, the muscle is transferred to the denervated side to restore its neurovascular pedicle. The results demonstrate function in 8 of the 10 grafts, with the two failures relating to early vascular thrombosis. |
| 15. | 117 | Manktelow, RT | 1984 | Plastic and Reconstructive Surgery | Muscle transplantation by fascicular territory | Introduction of a new concept using only a small segment of the gracilis muscle under one motor nerve fascicle control for reanimation. A case report of one illustrative patient was discussed in detail along with the operative details. They discussed separating the gracilis into different fascicles innervated by different nerve fascicle for different reanimation function. |
| 16. | 99 | Arai H | 1995 | Journal of Neurosurgery | Hemihypoglossal-facial nerve anastomosis in treating unilateral facial palsy after acoustic neurinoma resection | Report on 8 patients with hemihypoglossal-facial nerve anastomosis. It was concluded that hemihypoglossal–facial nerve anastomosis results in good facial reanimation as long as the procedure is performed early after the onset of facial palsy and that this procedure may reduce the degree of hemiglossal atrophy in comparison with classic hypoglossal–facial nerve anastomosis. |

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| 17. | 97 | Frey M | 1994 | Plastic and Reconstructive Surgery | Development of a new documentation system for facial movements as a basis for the international registry for neuromuscular reconstruction in the face | On the basis of the results, three real static points and representative dynamic points were selected as well as relations of these points most representative for the different facial movements. For data collection, a simple instrument (Frey's faciometer) was developed. A preliminary report is given on the clinical application of this new instrument. |
| 18. | 96 | Atlas, MD | 1997 | Laryngoscope | A new technique for hypoglossal-facial nerve repair | Report on 8 patients who underwent hemihypoglossal-facial nerve anastomosis. The authors conclude that by employing the techniques described highly satisfactory cosmetic and functional results may be expected, without compromising hypoglossal nerve function. |
| 19. | 95 | Sawamura, Y | 1997 | Journal of Neurosurgery | Hypoglossal-facial nerve side-to-end anastomosis for preservation of hypoglossal function: Results of delayed treatment with a new technique | This technique used in four patients with facial paralysis greater than 24 months, and provided satisfactory facial reanimation, with no evidence of hemi-tongue atrophy or dysfunction. It also preserved glossal function, so this technique constitutes a successful approach in patients with long-standing facial paralysis who wish to maintain tongue function. |
| 20. | 94 | Whitney, TM | 1990 | Plastic and Reconstructive Surgery | The serratus anterior free-muscle flap - | Report on the serratus anterior free flap for reanimation. A single flap failure occurred, and four patients experienced partial flap loss. |

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| | | | | | experience with 100 consecutive cases | Emergent reexploration for suspected vascular occlusion was required in six flaps, with an 83 percent salvage rate. Significant complications occurred in 18 percent of recipient sites and 12 percent of donor sites, with eight patients developing seroma/hematoma. All patients retained full shoulder range of motion. |
| 21. | 92 | Hohman, Marc | 2014 | Laryngoscope | Etiology, Diagnosis, and Management of Facial Palsy: 2000 Patients at a Facial Nerve Center | Discussion of their clinical experiences in 200 patients. Bell's palsy remains the most common facial palsy; females present more often for evaluation. Comprehensive diagnostic investigation is necessary in atypical cases, and management must be multidisciplinary. The algorithms presented outline a single center's approach to the facial palsy patient, providing a framework that clinicians caring for these patients may adapt to their specific setting. |
| 22. | 89 | Andrel, H | 1973 | Chirurgia Plastica | Reconstruction of face through cross-face-nerve transplantation in facial paralysis | Five cases are discussed here with respect to clinical and electrical (EMG) findings after cross face nerve graft to re-anastomose to the paralyzed side. Results after 18, 12, 8, 4 months are reported with consideration of indication, technical procedure, construction of anastomoses, selection of facial nerve fascicles, scheduling of operative phases, results obtained, failures observed. |
| 23. | 87 | Coombs, CJ | 2009 | Journal of Plastic Reconstructive | Masseteric-facial nerve coaptation - | Clinical description of masseteric nerve innervated gracilis in 8 patients, along with |

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| | | | | and Aesthetic Surgery | an alternative technique for facial nerve reinnervation | pathology evaluation of axon counts. Discussed advantage of this method, include the ease of dissection, constant and reliable anatomy, powerful reinnervation of the facial muscles without donor site morbidity and the potential for return of spontaneous facial movement. |
| 24. | 87 | Stennert, E | 1979 | Clinics in Plastic Surgery | Hypoglossal facial anastomosis - its significance for modern facial surgery .1. combined approach in extra-temporal facial-nerve reconstruction .2. | A comparison of clinical and neurophysiologic results of hypoglossal anastomosis with those of intratemporal reconstruction substantiates the favorable literature about hypoglossal repair. The procedure may be combined with procedures using several regenerative nerves to improve functional and cosmetic results. |
| 25. | 85 | Kumar, Pav | 2002 | Plastic and Reconstructive Surgery | Cross-face nerve graft with free-muscle transfer for reanimation of the paralyzed face: A comparative study of the single-stage and two-stage procedures | Description of traditional two stage gracilis-cross face nerve graft and one stage gracilis-cross face nerve graft for reanimation.<br>The two-stage method scored good symmetry at rest in 67 percent, compared with 20 percent for the single-stage method. There were fewer complications with the single-stage method, and none of the patients had any problems relating to the donor site. The period of rehabilitation was reduced by 10 months with the single-stage method. |

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| 26. | 85 | Harii, K | 1979 | Clinics in Plastic Surgery | Micro-neurovascular free muscle transplantation for reanimation of facial paralysis | Discussion of Dr. Harii approach to reanimation. A case series of 18 patients with various muscles (gracilis, extensor hallicis brevis, and latissimus dorsi), and various recipient nerve (facial, deep temoral, hypoglossal, cross-face nerve graft) were presented. Operative procedures and results are summarized with almost all patients achieving good results. |
| 27. | 84 | Navissano, M | 2005 | Microsurgery | Neurotube((R)) for facial nerve repair | Report on results of using Neurotube for segmental nerve defect. Their conclusion included: The limits of this method are: 1) it can only be used with gaps of less than 3 cm; 2) it is quite costly; 3) there are reports of possible intolerance; and 4) it is not suitable for lesions of the proximal part of the facial nerve. |
| 28. | 84 | Freilinger, G | 1975 | Plastic and Reconstructive Surgery | New technique to correct facial paralysis | Discussion of two cases of unilateral facial paralysis, with advanced muscle atrophy. Their technique combines a free nerve graft across the face with a denervated temporalis muscle and extensor muscle to the foot. The result in both cases was good. |
| 29. | 83 | Koshima, I | 1994 | Plastic and Reconstructive Surgery | Free rectus femoris muscle transfer for one-stage reconstruction of | Report on anatomic study and results on 7 patients. The rectus muscle advantages include: (1) the safety and simplicity of one arterial supply for anastomosis (2) the femoral nerve reaches the contralateral facial nerve for suturing; (3) a |

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| | | | | | established facial paralysis | two-team operation is possible with the patient laying supine; (4) the force and distance of contraction appropriately reanimate the face; (5) the rectus muscle can segmented for replacing facial muscles; (6) the tendinous fascia ends work well for anchoring sutures; and (7) no loss of donor leg function. |
| 30. | 80 | Guntinas-Lichius O | 2006 | American Journal of Surgery | Postoperative functional evaluation of different reanimation techniques for facial nerve repair | Analysis of outcomes of various facial nerve grafting and anastomosis (facial-facial nerve anastomosis, grafting, hypoglossal-facial nerve anastomosis, or hypoglossal-facial interpositional jump nerve) using visual analog scale and EMG in 53 patients. All analyzed facial reanimation techniques seem to lead nearly similar and satisfactory results. |
| 31. | 79 | Klebuc, MJ | 2011 | Plastic and Reconstructive Surgery | Facial Reanimation Using the Masseter-to-Facial Nerve Transfer | Evaluation of 10 patients who underwent masseter to facial nerve transfer for reanimation. Motion developed average 5.6 months after the transfer, with 40% of patients developing effortless smile by 19 months. |
| 32. | 79 | Johnson, PC | 1994 | Annals of Plastic Surgery | Simultaneous quantitation of facial movements - the maximal static response assay of facial-nerve function | Development of new method of isolated facial movement in face region of the face. The assay has potential to be used as an adjunct to the presently used ordinal scales of facial nerve function by allowing actual quantitation of region-specific facial movement and vector planning during surgery. |

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| 33. | 78 | Terzis, JK | 2008 | Facial Plastic Surgery | Nerve transfers in facial palsy | Discussion of the author experience with facial reanimation reconstruction. The selected motor nerve must provide strong muscle contraction and allow the patient to control the facial movements. This paper presents the author's experience in selecting motor nerves that can function as possible donor nerves for dynamic facial reanimation. |
| 34. | 77 | Lifchez, SD | 2005 | Facial Plastic Surgery | Cortical adaptation to restoration of smiling after free muscle transfer innervated by the nerve to the masseter | Review of the authors outcomes with 3 Mobius patients with reanimation using the masseteric nerve. Two childs were able to smile independently without biting down. Eraly age contribute to cortical adaptation to smiling. |
| 35. | 75 | Manni, JJ | 2001 | American Journal of Surgery | Reanimation of the paralyzed face by indirect hypoglossal-facial nerve anastomosis | Evaluation in 39 patients. Indirect hypoglossal-facial anastomosis is the preferred technique in most patients for whom the classical direct hypoglossofacial anastomosis is indicated. |
| 36. | 72 | Hontanilla, B | 2008 | Journal of Plastic Reconstructive and Aesthetic Surgery | Automatic three-dimensional quantitative analysis for evaluation of facial movement | Development of new 3D facial grading system and testing in 20 healthy volunteers. The accuracy of the FACIAL CLIMA system facial movement evaluation is demonstrated and also the high intrarater and interrater reliability. The advantages compared to other facial movement evaluation systems include short calibration and |

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| | | | | | | measuring time, straightforward operation, and it providing distances, velocities, and areas. |
| 37. | 71 | Banks, CA | 2015 | Plastic and Reconstructive Surgery | Clinician-Graded Electronic Facial Paralysis Assessment: The eFACE | Development and evaluation of new reanimation grading scale consisting of 16 items visual analogue scale, with high interrater and intrarater reliability. |
| 38. | 70 | Frey, M | 2004 | Plastic and Reconstructive Surgery | Dynamic reconstruction of eye closure by muscle transposition or functional muscle transplantation in facial palsy | First study to evaluate dynamic 3D eyelid movement pre and post operatively. 34 of 44 patients were treated with temporalis muscle transposition for reanimation and eye closure. Temporalis muscle transposition and functional muscle transplantation for reanimating the eye and mouth are reliable methods for reconstructing eye closure and may reduce secondary operative corrections. |
| 39. | 69 | Byrne, PJ | 2007 | Archives of Facial Plastic Surgery | Temporalis tendon transfer as part of a comprehensive approach to facial reanimation | Case series of 7 patients who underwent temporalis muscle transfer, with achievement of satisfactory result with high patient satisfaction. This procedure results in improved form and function, may often be performed in a minimally invasive manner, and eliminates the facial asymmetry typically produced by temporalis transfer. |
| 40. | 69 | Hadlock, TA | 2006 | Laryngoscope | Multimodality approach to management of the paralyzed face | Review of the authors experience with 337 patients treated with various modalities. Facial paralysis is best managed using a multimodality approach that includes surgical |

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| | | | | | | interventions, physical therapy, and chemodenervation. Surgical intervention for reanimation was discussed. |
| 41. | 69 | Hammerschlag, PE | 1999 | Laryngoscope | Facial reanimation with jump interpositional graft hypoglossal facial anastomosis and hypoglossal facial anastomosis: Evolution in management of facial paralysis | Case series of 18 patients who underwent jump interpositional graft hypoglossal-facial anastomosis.<br>No hemilingual deficiency was noted. In contrast to the HFA, this procedure can be used by patients with concomitant lower cranial nerve paralysis (except hypoglossal), and bilateral facial paralysis. Hypertonia, synkinesis, and lagophthalmus were less. |
| 42. | 69 | A L Dellon | 1985 | Journal of Reconstructive Microsurgery | Segmentally innervated latissimus dorsi muscle microsurgical transfer for facial reanimation | Describe are the anatomic dissections and clinical experience using a small segmentally innervated portion of the latissimus dorsi muscle to restore facial animation. |
| 43. | 68 | Hadlock, Tessa A. | 2012 | Archives of Facial Plastic Surgery | Toward a Universal, Automated Facial Measurement Tool in Facial Reanimation | Development of automated facial function software. FACE software produces accurate measurements of facial landmarks and facial movements and is sensitive to paralysis. Given its efficiency, it serves as a useful tool in the clinical setting for zonal facial movement analysis in |

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| | | | | | | comprehensive facial nerve rehabilitation programs. |
| 44. | 68 | Malik, TH | 2005 | Otology & Neurotology | A comparison of surgical techniques used in dynamic reanimation of the paralyzed face | Comparison of three surgical techniques including end-to-end anastomosis, cable nerve graft interposition, and classic faciohypoglossal transposition. End-to-end anastomosis confers the best facial function, followed by cable nerve graft interposition and then classic faciohypoglossal transposition. Contrary to some previous opinions, improvement in facial function can still occur 2 years after surgical repair, particularly with classic faciohypoglossal transposition. |
| 45. | 67 | Terzis, JK | 2000 | Plastic and Reconstructive Surgery | Microsurgical strategies in 74 patients for restoration of dynamic depressor muscle mechanism: A neglected target in facial reanimation | This article presents innovative approaches to restore dynamic depressor muscle function, which so far has been a neglected area of facial reanimation according to the authors. |
| 46. | 65 | Rose, EH | 2005 | Plastic and Reconstructive Surgery | Autogenous fascia lata grafts: Clinical applications in reanimation of the totally or partially paralyzed face | The authors utilized fascia lata alone or in combination with dynamic muscle transfer in 35 patients. Early placement of autogenous fascia lata restores static balance of the deeper facial architecture in repose. Functional improvement of chewing, fluid retention, speech articulation, smile symmetry, and ectropion is immediate. |

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| 47. | 64 | Samii, M | 1994 | Actaneurochirugica | Indication, technique and results of facial-nerve reconstruction | Descriptive results of 160 patients with various nerve discontinuity and discussion of various treatment modalities ranging from nerve graft for a missing nerve segment to cross face nerve graft. All of their patients achieved satisfactory functional and cosmetic results. No muscle transplantation was discussed. |
| 48. | 64 | Manktelow, RT | 1984 | Clinics in Plastic Surgery | Free Muscle Transplantation for Facial Paralysis | A case report discussion the transplantation of a segment of the gracilis muscle for facial reanimation with ipsilateral buccal nerve branch anastomosis, with good functional outcome. |
| 49. | 63 | Faria, JCM | 2007 | Annals of Plastic Surgery | Nerve Sources for Facial Reanimation with Muscle Transplant in Patients with Unilateral Facial Palsy - Clinical analysis of 3 techniques | Case series where different source nerve and muscles were used for reanimation, including the 2-stage cross face nerve graft-gracilis muscle, 1-stage latissimus dorsi muscle and cross face nerve graft, and one stage gracilis muscle with masseteric nerve. The cross face nerve graft groups have 34-45% emotional smile, but the one stage gracilis muscle-masseteric nerve achieved more uniform and predictable result than the other two methods. |
| 50. | 62 | Cusimano, MD | 1994 | Neurosurgery | Partial Hypoglossal to Facial-Nerve Anastomosis for Reinnervation of the Paralyzed Face in Patients with Lower Cranial Nerve | Description of partial hypoglossal to facial anastomosis that preserve hypoglossal nerve function while providing adequate facial reanimation in those with still preserved muscle motor end plate function. |

| Supplementary Table 1 | |
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| **Country** | **Citations** |
| USA | 18 |
| Japan | 6 |
| Canada | 6 |
| Australia | 4 |
| Austria | 4 |
| Germany | 3 |
| UK | 3 |
| Spain | 1 |
| Netherlands | 1 |
| Italy | 1 |
| Switzerland | 1 |
| France | 1 |
| Brazil | 1 |
| Total | 50 |

Supplementary Table 2

| Rank | Number of Citations | Author | Year | Journal | Title | Institution |
|---|---|---|---|---|---|---|
| 1. | 464 | Harii K et al | 1976 | Plastic & Reconstructive Surgery | Free gracilis muscle transplantation, with microneurovascular anastomoses for treatment of facial paralysis - preliminary-report | Tokyo Metropolitan Police Hospital |
| 2. | 204 | May M et al | 1991 | Otolaryngology-Head and Neck | Hypoglossal-facial nerve interpositional-jump graft for facial reanimation without tongue atrophy | University of Pittsburgh |
| 3. | 181 | Terzis JK & Noah ME | 1997 | Plastic & Reconstructive Surgery | Analysis of 100 cases of free-muscle transplantation for facial paralysis | International Institution of Reconstructive Microsurgery, Virginia |
| 4. | 179 | Manktelow, RT | 2006 | Plastic & Reconstructive Surgery | Smile reconstruction in adults with free muscle transfer innervated by the masseter motor nerve: Effectiveness and cerebral adaptation | Toronto General Hospital |
| 5. | 163 | Harii, K | 1998 | Plastic & Reconstructive Surgery | One-stage transfer of the latissimus dorsi muscle for reanimation of a paralyzed face: A new alternative | University of Tokyo |

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| 6. | 154 | Obrien, BM | 1980 | British Journal of Plastic Surgery | Cross-facial nerve grafts and microneurovascular free muscle transfer for long established facial palsy | St. Vincent's Hospital |
| 7. | 139 | Zuker, RM | 2000 | Plastic and Reconstructive Surgery | Facial animation in children with Mobius syndrome after segmental gracilis muscle transplant | The Hospital for Sick Children. |
| 8. | 136 | Bae, YC | 2006 | Plastic & Reconstructive Surgery | 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 | The Hospital for Sick Children |
| 9. | 136 | Labbe, D | 2000 | Plastic & Reconstructive Surgery | Lengthening temporalis myoplasty and lip reanimation | Caen University Hospital |
| 10 | 122 | Coulson, SE | 2005 | Otolaryngology-Head and Neck | Reliability of the Sydney, Sunnybrook, and House Brackmann facial grading systems to assess voluntary | University of Sydney |

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| | | | | | movement and synkinesis after facial nerve paralysis | |
| 11 | 119 | Terzis, JK | 2009 | Plastic and Reconstructive Surgery | The Babysitter Procedure: Minihypoglossal to Facial Nerve Transfer and Cross-Facial Nerve Grafting | Microsurgical Research Center, Virginia |
| 12 | 119 | Terzis, JK | 1989 | Plastic and Reconstructive Surgery | Pectoralis minor - a unique muscle for correction of facial palsy | East Viriginia Medical School |
| 13 | 118 | Obrien, BM | 1990 | Plastic and Reconstructive Surgery | Results of management of facial palsy with microvascular free-muscle transfer | St. Vincent's Hospital |
| 14 | 118 | Harrison, DH | 1985 | Plastic and Reconstructive Surgery | The pectoralis minor vascularized muscle graft for the treatment of unilateral facial palsy | Mount Vernon Hospital, Northwick Park Hospital, Edgware General Hospital, and Barnet General Hospital |
| 15 | 117 | Manktelow, RT | 1984 | Plastic and Reconstructive Surgery | Muscle transplantation by fascicular territory | University of Toronto, Toronto General Hospital, and The Hospital for Sick Children |
| 16 | 99 | Arai H | 1995 | Journal of Neurosurgery | Hemihypoglossal-facial nerve anastomosis in treating | Juntendo University, Tokyo |

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| | | | | | unilateral facial palsy after acoustic neurinoma resection | |
| 17 | 97 | Frey M | 1994 | Plastic and Reconstructive Surgery | Development of a new documentation system for facial movements as a basis for the international registry for neuromuscular reconstruction in the face | University of Zurich |
| 18 | 96 | Atlas, MD | 1997 | Laryngoscope | A new technique for hypoglossal-facial nerve repair | St. Vincent's Hospital, Sydney |
| 19 | 95 | Sawamura, Y | 1997 | Journal of Neurosurgery | Hypoglossal-facial nerve side-to-end anastomosis for preservation of hypoglossal function: Results of delayed treatment with a new technique | University of Hokkaid |
| 20 | 94 | Whitney, TM | 1990 | Plastic and Reconstructive Surgery | The serratus anterior free-muscle flap - experience with 100 consecutive cases | Davis Medical Center |
| 21 | 92 | Hohman, Marc | 2014 | Laryngoscope | Etiology, Diagnosis, and Management of Facial Palsy: 2000 Patients at a Facial Nerve Center | Massachusetts Eye and Ear Infirmary |

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| 22 | 89 | Andrel, H | 1973 | Chirurgia Plastica | Reconstruction of face through cross-face-nerve transplantation in facial paralysis | Innsbruck University Hospital |
| 23 | 87 | Coombs, CJ | 2009 | Journal of Plastic Reconstructive and Aesthetic Surgery | Masseteric-facial nerve coaptation - an alternative technique for facial nerve reinnervation | Royal child hospital and The Alfred Hospital |
| 24 | 87 | Stennert, E | 1979 | Clinics in Plastic Surgery | Hypoglossal facial anastomosis - its significance for modern facial surgery .1. combined approach in extra-temporal facial-nerve reconstruction .2. | Universitäts Klinik |
| 25 | 85 | Kumar, Pav | 2002 | Plastic and Reconstructive Surgery | Cross-face nerve graft with free-muscle transfer for reanimation of the paralyzed face: A comparative study of the single-stage and two-stage procedures | Whiston hospital |
| 26 | 85 | Harii, K | 1979 | Clinics in Plastic Surgery | Micro-neurovascular free muscle transplantation for reanimation of facial paralysis | University of Tokyo Hospital |

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| 27 | 84 | Navissano, M | 2005 | Microsurgery | Neurotube((R)) for facial nerve repair | CTO Hospital Turin |
| 28 | 84 | Freilinger, G | 1975 | Plastic and Reconstructive Surgery | New technique to correct facial paralysis | Surgical University Clinic Vienna |
| 29 | 83 | Koshima, I | 1994 | Plastic and Reconstructive Surgery | Free rectus femoris muscle transfer for one-stage reconstruction of established facial paralysis | Kawasaki medical school |
| 30 | 80 | Guntinas-Lichius O | 2006 | American Journal of Surgery | Postoperative functional evaluation of different reanimation techniques for facial nerve repair | Cologne University |
| 31 | 79 | Klebuc, MJ | 2011 | Plastic and Reconstructive Surgery | Facial Reanimation Using the Masseter-to-Facial Nerve Transfer | The Methodist Hospital, Houston |
| 32 | 79 | Johnson, PC | 1994 | Annals of Plastic Surgery | Simultaneous quantitation of facial movements - the maximal static response assay of facial-nerve function | University of Pittsburg |
| 33 | 78 | Terzis, JK | 2008 | Facial Plastic Surgery | Nerve transfers in facial palsy | Eastern Viriginia Medical School |
| 34 | 77 | Lifchez, SD | 2005 | Facial Plastic Surgery | Cortical adaptation to restoration of smiling after | Medical College of Wisconsin |

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| | | | | | free muscle transfer innervated by the nerve to the masseter | |
| 35 | 75 | Manni, JJ | 2001 | American Journal of Surgery | Reanimation of the paralyzed face by indirect hypoglossal-facial nerve anastomosis | University of Maastricht |
| 36 | 72 | Hontanilla, B | 2008 | Journal of Plastic Reconstructive and Aesthetic Surgery | Automatic three-dimensional quantitative analysis for evaluation of facial movement | University of Navarra |
| 37 | 71 | Banks, CA | 2015 | Plastic and Reconstructive Surgery | Clinician-Graded Electronic Facial Paralysis Assessment: The eFACE | From the Division of Facial Plastic and Reconstructive Surgery, Department of Otolaryngology/Head and Neck Surgery, Harvard Medical School/Massachusetts Eye and Ear Infirmary, Harvard Medical School/Boston Children's Hospital, the Department of Mathematical Sciences, Bentley University; and the Department of Otolaryngology–Head and Neck Surgery, Alaska Native |

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| | | | | | | Medical Center, Alaska Native Tribal Health Consortium. |
| 38 | 70 | Frey, M | 2004 | Plastic and Reconstructive Surgery | Dynamic reconstruction of eye closure by muscle transposition or functional muscle transplantation in facial palsy | University of Vienna |
| 39 | 69 | Byrne, PJ | 2007 | Archives of Facial Plastic Surgery | Temporalis tendon transfer as part of a comprehensive approach to facial reanimation | Johns Hopkins University |
| 40 | 69 | Hadlock, TA | 2006 | Laryngoscope | Multimodality approach to management of the paralyzed face | Massachusetts Eye and Ear Infirmary |
| 41 | 69 | Hammersc hlag, PE | 1999 | Laryngoscope | Facial reanimation with jump interpositional graft hypoglossal facial anastomosis and hypoglossal facial anastomosis: Evolution in management of facial paralysis | New York University Medical Centre |
| 42 | 69 | A L Dellon | 1985 | Journal of Reconstructive Microsurgery | Segmentally innervated latissimus dorsi muscle microsurgical transfer for facial reanimation | Johns Hopkins University School of Medicine, University of Toronto |

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| 43 | 68 | Hadlock, Tessa A. | 2012 | Archives of Facial Plastic Surgery | Toward a Universal, Automated Facial Measurement Tool in Facial Reanimation | Massachusetts Eye and Ear Infirmary |
| 44 | 68 | Malik, TH | 2005 | Otology & Neurotology | A comparison of surgical techniques used in dynamic reanimation of the paralyzed face | Manchester Royal Infirmary |
| 45 | 67 | Terzis, JK | 2000 | Plastic and Reconstructive Surgery | Microsurgical strategies in 74 patients for restoration of dynamic depressor muscle mechanism: A neglected target in facial reanimation | Microsurgical Research Center, Virginia |
| 46 | 65 | Rose, EH | 2005 | Plastic and Reconstructive Surgery | Autogenous fascia lata grafts: Clinical applications in reanimation of the totally or partially paralyzed face | Mount Sinai Medical Center |
| 47 | 64 | Samii, M | 1994 | Actaneurochirugica | Indication, technique and results of facial-nerve reconstruction | Nordstadt Hospital |
| 48 | 64 | Manktelow, RT | 1984 | Clinics in Plastic Surgery | Free Muscle Transplantation for Facial Paralysis | Toronto General Hospital |
| 49 | 63 | Faria, JCM | 2007 | Annals of Plastic Surgery | Nerve Sources for Facial Reanimation with Muscle Transplant in Patients with | Hispital das Clinicas |

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| | | | | | Unilateral Facial Palsy - Clinical analysis of 3 techniques | |
| 50 | 62 | Cusimano, MD | 1994 | Neurosurgery | Partial Hypoglossal to Facial-Nerve Anastomosis for Reinnervation of the Paralyzed Face in Patients with Lower Cranial Nerve Palsies – Technical Note | University of Toronto |

Supplementary Material

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**Supplemental Data File (.doc, .tif, pdf, etc.)**

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