**Original Research Article**

# Comparison of PNF and NRE with Conventional Therapy and Home-Based Exercise plus Facial Nerve Stimulation in Bell's Palsy

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## Abstract:

The present study compared proprioceptive neuromuscular facilitation (PNF) and neuromuscular re-education (NRE) combined with conventional therapy versus conventional therapy alone with home-based exercises and facial nerve stimulation plays a significant role in alleviating facial disability among individuals affected by Bell's palsy. Thirty-two patients aged 20–70 years were purposively selected and equally allocated into two groups, viz. Group-A where patients were treated with PNF and NRE plus interrupted galvanic stimulation (IGS), facial massage (FM), and home-based exercises (HBE), while in Group-B, patients were treated with IGS, FM, and HBE only. Outcome measures included the Facial Disability Index–Physical Function (FDI-PF), Facial Disability Index–Social Function (FDI-SF), Synkinesis Assessment Questionnaire (SAQ), and Sunnybrook Facial Grading Scale (SFGS).

At baseline, no significant inter-group differences were observed. Significant inter-group differences ($p< 0.001$) were reported in FDI-PF, FDI-SF, and SFGS afterintervention, favouring Group-A. Within Group-A, FDI-PF and SFGS significantly improved, while FDI-SF and SAQ

significantly decreased. Group-B also showed significant improvements, but to a lesser extent. The findings indicate that adding PNF and NRE to conventional therapy is more effective to enhance facial symmetry and minimize functional impairment in patients diagnosed with Bell's palsy.

**Keywords:** PNR technique, NRE technique, IGS, FM, HBs, Bell's palsy.

## Introduction

Bell's palsy refers to an acute facial paralysis of lower motor neuron origin due to dysfunction of the seventh cranial nerve[1]. Bell's palsy is frequently referred to as idiopathic facial palsy as its underlying cause remains unknown in most patients.The disorder produces a sudden impairment in voluntary movement of the muscles on the affected side of the face, which is clinically described as facial palsy[2].

Population-level research has shown that Bell's palsy occurs at a rate of roughly 20 to 30 cases per 100,000 persons each year globally [3]. It represents the leading cause of sudden-onset paralysis affecting one side of the face., accounting for nearly two-thirds to three-quarters of such cases.Patho-physiologically, the facial nerve becomes damaged primarily due to inflammation and edema within the nerve itself. This inflammatory swelling causes the nerve to enlarge at the point where it exits the skull through the stylomastoid foramen and traverses the constricted bony facial canal. Because the canal does not allow room for expansion, the swollen nerve becomes compressed, leading to ischemia. As a result, the blood supply to the nerve fibers is compromised, producing conduction block and neural dysfunction. The hallmark clinical manifestation of this process is the abrupt loss of voluntary movement of the facial expression muscles on one side of the face, which remains the most prominent physical presentation of Bell's palsy [2].

The clinical presentation of Bell's palsy is characterized by a range of functional and visible deficits affecting one side of the face. Individuals with this condition usually cannot fully close the affected eye (lagophthalmos) and have impaired normal lip movement, such as when attempting to smile, pucker, or show the teeth. At rest, the involved side of the face often appears flattened and may visibly "droop" due to loss of muscle tone. The lower

eyelid may sag and turn outward, a condition known as *ectropion*, which further contributes to ocular exposure and irritation.

These motor impairments lead to significant difficulties with basic activities such as eating and drinking. Because effective lip seal is compromised, patients often struggle to retain food and fluids within the oral cavity, resulting in drooling and spillage. Speech clarity is also reduced, as proper articulation of labial consonants (such as *p, b, m, f,* and *v*) depends on coordinated lip movement and closure.

Ocular complications are common and clinically important. Reduced or absent tear production in the affected eye leads to dryness, increasing the risk of corneal exposure, irritation, and potential ulceration if not adequately protected. In addition, patients may experience heightened sensitivity to sudden or loud sounds (hyperacusis) because the stapedius muscle of the middle ear becomes paralyzed, which is normally innervated by the facial nerve. Disturbances in taste sensation affecting onthe anterior two-thirds of the tongue can result from involvement of the chorda tympani branch of the facial nerve[4].

Some patients also report a sense of general malaise, fatigue, or flu-like symptoms during the first few days following the onset of Bell's palsy, along with pain or discomfort in the region of the ipsilateral mastoid process, commonly referred to as *otalgia* [5]. However, it is important to note that a significant proportion of patients do not experience either mastoid pain or systemic malaise, and the condition may present without any associated discomfort in many cases.

When symptoms begin, facial paralysis may be full or partial. Bell's palsy generally involves all branches of the facial nerve on the affected side, causing generalized loss of voluntary facial expression, such as around the mouth and same-side eye, but in some individuals, selective involvement of one or two branches leads to localized weakness instead.

Several causes of facial palsy should be taken into account when making a differential diagnosis, among them infectious disorders such as herpes zoster–associated Ramsay Hunt syndrome and Lyme diseasecaused by *Borrelia burgdorferi*, and otitis media. Other causes

include iatrogenic facial nerve damage following surgical procedures, congenital facial nerve palsy, neurosarcoidosis, demyelinating disorders such as multiple sclerosis, and immune-mediated neuropathies such as Guillain–Barré syndrome [6].

Bell's palsy is commonly managed using a combination of physical therapy interventions and patient education aimed at promoting nerve recovery, preventing secondary complications, and restoring facial function. Bell's palsy is managed in physiotherapy using techniques such as kinesio-therapy, massage, cryotherapy, and electrotherapy, all of which are used to stimulate muscle activity, reduce stiffness, and maintain tissue health [7,8,5].

ES applied to paralyzed facial muscles has traditionally been a widely used therapy for individuals with Bell's palsy, with the intention of preventing muscle atrophy, improving circulation, and facilitating neuromuscular re-education during the process of nerve regeneration [9,10,11].

However, traditional physical therapy approaches that rely primarily on facial massage and according to multiple studies, the repetitive training of common facial expressions within a general exercise program offers minimal benefit.[12,13]. In contrast, more specialized neuro-facilitatory approaches have been proposed and investigated. These include PNF, NRE, acupuncture, and mime therapy, all of which aim to enhance selective muscle activation, improve motor control, and promote more symmetrical and coordinated facial movements [12].

Different combinations of physiotherapeutic interventions have also been investigated in earlier studies in order to determine the most effective approach for restoring facial symmetry and functional movement in individuals with Bell's palsy. Building on this background, the present study was designed with the primary objective of evaluating and comparing the effectiveness of two therapeutic protocols: (1) facial Neuromuscular Re-education (NRE) combined with Individualized Graded Stimulation (IGS) and Motor Facilitation Methods (MFM), and (2) House–Brackmann Scale (HBS)-guided therapy with IGS and MFM, along with a structured Home-Based Exercise (HBE) program performed in front of a mirror.

The aim was to determine which combination more effectively improves facial muscle control, symmetry, and overall functional recovery in individuals with Bell's palsy.

## Materials and Methods

### Samples:

The study was initially conducted with a small cohort of 20 participants at CMC Hospital, Ludhiana, Punjab, India [14]. To strengthen the validity and generalizability of the earlier results, the current research was subsequently carried out using an expanded sample size.

At the outset,57 confirmedcases of Bell's palsy (of both sexes) were considered. These individuals, within the age range of 20 to 70 years, were randomly selected from Ropar, Punjab, India. Of the 57 patients initially considered, 32 met the eligibility criteria and gave informed consent to actively participate in the study.The eligible participants were subsequently divided equally into two separate treatment groups: Group-A and Group-B., each consisting of 16 subjects. Group-A comprised 16 patients who received a combined intervention protocol that included PNF and facial NRE, also with IGS delivered using a rectangular waveform with a pulse duration of 100 ms, administered in three sets of 30 muscle contractions per session, in addition to Motor Facilitation Methods (MFM) and a HBE program.

Group-B consisted of 16 patients who were treated with IGS and MFM, together with a structured HBE program was carried out in front of a mirror to offer visual feedback and improve motor control.Before commencing the study, written informed consent was secured from all participants, and approval was obtained from the Institutional Ethics Committee.

### Methods

### OutcomeMeasures

The outcome measures used in the present study included the Facial Disability Index – Physical Function (FDI–PF), which evaluates the physical limitations associated with facial paralysis; the Facial Disability Index – Social Function (FDI–SF), which assesses the psychosocial and social impact of facial dysfunction; the Synkinesis Assessment Questionnaire (SAQ), which measures

the presence and severity of abnormal associated facial movements; and the Sunnybrook Facial Grading Scale (SFGS), a widely accepted clinical tool for grading facial nerve function and symmetry at rest and during voluntary movement. Collectively, these instruments offered a thorough evaluation of both functional outcomes and quality-of-life measures associated with Bell's palsy.

**Proprioceptive Neuromuscular Facilitation (PNF)**

PNF is a therapeutic approach based on manual resistance that replicates basic and functional movement patterns. It facilitates and accelerates neuromuscular responses by specifically stimulating proprioceptors in the muscles, tendons, and joints.Depending on how it is applied, PNF can result in either facilitation of muscle activity or inhibition of unwanted or excessive movement.

In the management of facial paralysis, several PNF techniques were utilized, including rhythmic initiation, repeated stretch (also referred to as repeated contractions), combinations of isotonic contractions, and percussion applied to the tendons, muscle margins, and fascia. These techniques were administered systematically individually to each of the facial muscles.

In addition, the irradiation principle of PNF was applied to promote contraction in the weaker muscles by using stronger muscle groups to enhance neuromuscular activation. The primary objective of using PNF in this context was to enhance selective muscle control, enhance facial symmetry, and promote coordinated facial movements.

**Neuromuscular Re-education Technique (NRE)**

The facial NRE is a therapeutic process designed to improve the recovery and restoration of normal and well-coordinated patterns of facial movementwhile simultaneously eliminating or minimizing unwanted facial movements and abnormal expression patterns that may develop after facial nerve injury[15]. The primary goal of this approach is to help patients regain selective control over individual facial muscles and improve symmetry during both rest and voluntary activity.

This technique is based on patient education and the structured application of external feedback, such as visual (mirror), tactile, and verbal cues, to promote relearning of correct movement patterns. Through repeated, controlled practice, NRE aims to achieve neuroplastic changes within the central nervous system by reinforcing appropriate motor pathways. By emphasizing slow, precise, and selective facial movements, NRE reduces, as much as possible, the likelihood of developing maladaptive movement patterns, particularly synkinesis, which refers to involuntary muscle contractions that occur simultaneously with voluntary movements [16].

**Interrupted Galvanic Stimulation (IGS)**

The IGS using a rectangular waveform with a pulse duration of 100 ms was applied to the affected facial muscles. The stimulation protocol consisted of three sets, with 30 muscle contractions in each set, delivered in a controlled and graded manner. This form of electrical stimulation was used to activate denervated or weak facial muscles, improve local circulation, and assist in maintaining muscle contractility during the period of nerve recovery.

**Manual Facial Massage (MFM)**

The MFM was performed to enhance blood flow, reduce stiffness, and maintain the pliability of facial soft tissues. The massage techniques included effleurage for gentle warming and relaxation, finger-to-thumb kneading to mobilize deeper tissues, wringing to improve tissue elasticity, hacking and tapping for neuromuscular stimulation, and stroking to promote relaxation and lymphatic drainage. These techniques were systematically applied to all relevant facial muscle groups.

**Home-Based Exercises (HBE)**

A structured program of facial HBE performed in front of a mirror was taught to each patient and prescribed for a duration of four weeks. Patients were re-assessed after one month period to evaluate progress. The home exercise regimen included a series of specific facial movements designed to activate and coordinate the muscles of facial expression, such as: widening the eyes followed by frowning; tightly closing the eyes and then opening them widely; flaring the nostrils and relaxing; smiling and grinning; forming the lips into an “O” shape and attempting to whistle; filling the mouth with air and releasing it repeatedly; pronouncing vowels and their combinations

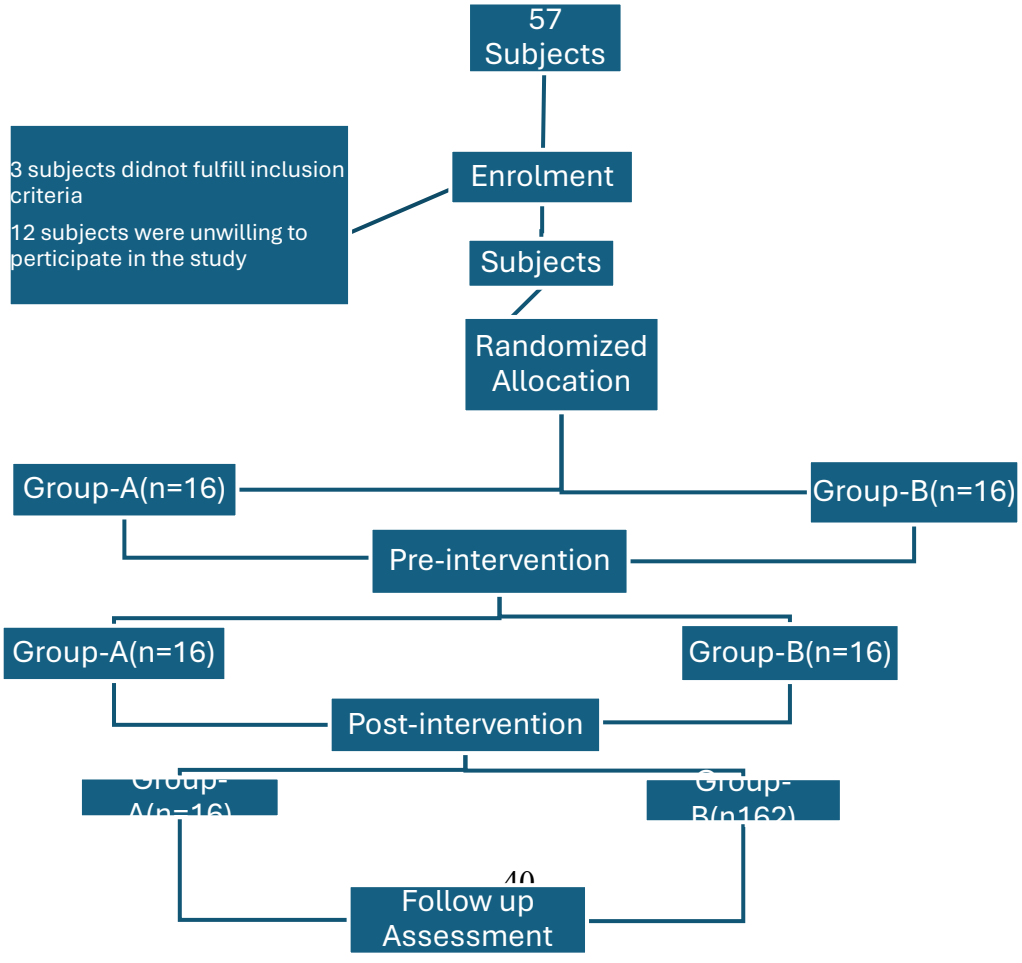
(e.g., “a–e–i–o–u” sequences); holding a straw in the mouth and practicing sucking and blowing; and mimicking the action of blowing up a balloon.

Patients were asked to perform these exercises in front of a mirror twice daily, completing approximately five repetitions of each movement at home. The use of the mirror provided visual feedback to enhance accuracy, symmetry, and motor control during practice.

**Statistical Analysis**

Conventional descriptive statistics, such as the mean, standard deviation, and percentage increase/decrease, were computed for all directly measured patient variables to summarize baseline characteristics and treatment outcomes. Data was analysed using SPSS, version 20.0.

Intra-group differences between pre- and post-intervention assessments were analyzed using the paired *t*-test, while inter-group comparisons were performed with the independent *t*-test. A significance level of 5% ($p < 0.05$) was adopted for all statistical analyses.



## Results

Table 1 presents the descriptive statistics of selected variables in Bell's palsy patients treated in two groups with different conditionsAt baseline (pre-intervention), no statistically significant differences were observed in FDI-PF, FDI-SF, SAQ, or SFGS between the patients allocated to Group-A and those in Group-B, indicating that the two groups were comparable before the start of treatment.

However, in the post-intervention condition, statistically significant differences ($p< 0.001$) were found between Group-A and Group-B for several outcome measures. Specifically, significant between-group differences were observed in FDI-PF ($t = 8.769$), FDI-SF ($t = 5.132$), and SFGS ($t = 6.123$), demonstrating superior post-treatment outcomes in one group compared with the other.

Comparison of selected variables of Bell's palsy patients in different conditions in Group-Aare shown in Table 2. The analysis revealed a statistically significant increase ($p< 0.001$) in FDI-PF ($t = 5.437$) and SFGS ($t = 10.218$), indicating marked improvement in physical facial function and overall facial grading following intervention. In contrast, statistically significant decreases ($p< 0.005–0.001$) were observed in FDI-SF ($t = 6.851$) and SAQ ($t = 7.019$), reflecting a reduction in social disability and synkinesis in patients with Bell's palsy after treatment in this group.

Table 3 presents the comparisons of the FDI-PF, FDI-SF, SAQ, and SFGS scores in patients with Bell's palsy treated in Group-B under pre- and post-intervention conditions.

The within-group analysis revealed statistically significant changes between baseline and post-treatment assessments. Specifically, a statistically significant decrease ($p< 0.004–0.001$) was observed in FDI-PF ($t = 12.131$), FDI-SF ($t = 7.998$), SAQ ($t = 4.784$), and SFGS ($t = 4.051$) scores in patients with Bell's palsy from pre- to post-intervention in Group-B, indicating meaningful improvements in physical function, social function, synkinesis, and overall facial grading following the intervention.

**Table 1. Descriptive statistics of selected variables in Bell's palsypatients treated in two groupswith different conditions**

| | Group-A | Group-B | | |
|---|---|---|---|---|

| Variables | Mean | S. D. | Mean | S.D. | t-value | p-value |
|---|---|---|---|---|---|---|
| Age (years) | 45.35 | 14.22 | 51.33 | 13.72 | 1.437 | 0.318 |
| FDI-PF (pre) | 60.41 | 22.66 | 67.32 | 7.92 | 1.371 | 0.475 |
| FDI-SF (pre) | 65.72 | 21.56 | 67.15 | 12.74 | 0.673 | 0.575 |
| FDI-PF (post) | 103.54 | 23.78 | 38.43 | 9.61 | 8-769 | **<0.001** |
| FDI-SF (post) | 46.53 | 10.55 | 33.53 | 5.82 | 5.132 | **<0.004** |
| SAQ (pre) | 88.65 | 6.87 | 86.42 | 7.01 | 1.542 | 0.199 |
| SAQ (post) | 67.73 | 10.74 | 67.83 | 9.55 | 0.861 | 0.485 |
| SFGS (pre) | 19.83 | 17.80 | 19.73 | 5.67 | 2.532 | 0.752 |
| SFGS (post) | 45.66 | 17.06 | 11.63 | 5.09 | 6.123 | **<0.001** |

**Table 2. Comparison of selected variables ofBell's palsy patients indifferent conditionsin Group-A**

| Variables | Pre-intervention | | Post- intervention | | t-value | p-value |
|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | | |
| FDI-PF | 60.41 | 22.66 | 103.54 | 23.78 | 5.437 | **<0.001** |
| FDI-SF | 65.72 | 21.56 | 46.53 | 10.55 | 6.851 | **<0.005** |
| SAQ | 88.65 | 6.87 | 67.73 | 10.74 | 7.019 | **<0.001** |
| SFGS | 19.83 | 17.80 | 45.66 | 17.06 | 10.218 | **<0.001** |

**Table 3.Comparison of selected variables of Bell's palsy patients indifferent conditionsin Group-B**

| Variables | Pre-intervention | | Post- intervention | | t-value | p-value |
|---|---|---|---|---|---|---|
| | Mean | S.D. | Mean | S.D. | | |
| FDI-PF | 67.32 | 7.92 | 38.43 | 9.61 | 13.032 | **<0.001** |
| FDI-SF | 67.15 | 12.74 | 33.53 | 5.82 | 8.435 | **<0.001** |
| SAQ | 86.42 | 7.01 | 67.83 | 9.55 | 5.352 | **<0.001** |
| SFGS | 19.73 | 5.67 | 11.63 | 5.09 | 4.835 | **<0.001** |

## Discussion

In the current study, no statistically significant difference was observed in the age distribution between participants in Group-A and Group-B, indicating that both groups were comparable in terms of demographic characteristics. It was also observed that prior to the intervention, there were no significant differences between the two groups in FDI-PF, FDI-SF, SAQ, anSFGS scores, confirming baseline equivalence with respect to physical function, social function, synkinesis, and overall facial grading.

However, following the intervention, statistically significant differences ($p < 0.001$) were observed between the groupsin FDI-PF, FDI-SF, and SFGS, demonstrating that the type of intervention applied had a meaningful impact on treatment outcomes. Within Group-A, a statistically significant improvement ($p < 0.001$) was observed in the FDI-PF and SFGS scores, indicating marked improvement in physical facial function and overall facial symmetry. Simultaneously, a statistically significant decrease ($p < 0.013–0.001$) was observed. in the FDI-SF and SAQ scores., reflecting reductions in social disability and synkinesis between the baseline and post-intervention evaluations.

In patients allocated to Group B, statistically significant reductions ($p < 0.003–0.001$) were noted in FDI-PF, FDI-SF, SAQ, and SFGS scores between baseline and post-evaluations, indicating improvement across all measured domains. However, the magnitude of improvement was greater in Group-A. The present results demonstrated a marked improvement in FDI-PF (64.15%) in Group-A, while significant decreases were noted in FDI-SF, SAQ, and SFGS in both Group-A (29.37%, 21.09%, and 42.93%, respectively) and Group-B (28.78%, 20.10%, and 41.06%, respectively). These findings indicate the greater efficacy of the combined techniques applied in Group-A for the treatment of Bell's palsy.

Various physiotherapy interventions have previously been reported for the treatment of Bell's palsy including PNF [4], NMR/NRE [17,18], electrical stimulation of paralyzed facial muscles [9,10,11], and conventional exercises such as facial massage. In the present study, patients in Group-A received a comprehensive treatment protocol, including PNF, NRE, IGS, MFM, and HBE, whereas patients in Group-B received only IGS, MFM, and HBE. The superior outcomes in Group-A support the added value of PNF and NRE in facial nerve rehabilitation.

Barbara et al. (2010) reported that PNF-based rehabilitation, when initiated in the early stage, led to a more rapid recovery and decreased facial disability in patients with Bell's palsy. Several other reports on the use of PNF in Bell's palsy rehabilitation have also shown that after PNF treatment, patients became more socially confident due to regained control over facial expressions and mimics. Furthermore, PNF-based physical therapy was found to facilitate quicker and more effective recovery compared with conventional physical therapy approaches, supporting the present findings [19,20].

Manikandan [18] demonstrated that individualized neuromuscular re-education (NRE) produced superior improvements in facial symmetry compared to conventional therapeutic interventions alone in individuals with facial palsy. The more favorable prognosis observed with proprioceptive neuromuscular facilitation (PNF), reflected in improved FDI-PF, FDI-SF,

SAQ, and SFGS scores, may be explained by enhanced activation and facilitation of the proprioceptive neuromuscular system achieved through PNF training[21]. PNF elicits adequately strong muscle contractions through the application of diagonal movement patterns combined with stretch and resistance. These repeated movements, grounded in the principles of irradiation and supplementary bilateral co-contraction, facilitate early neuromuscular recovery, thereby enhancing facial symmetry and decreasing facial disability in individuals with Bell's palsy [22,23]. A limited sample size constituted one of the study's primary limitations.

## Conclusion

Based on the results of the present study, it may be concluded that a treatment regimen incorporating PNF and NRE in addition to IGS (rectangular waveform, 100 ms pulse duration, three sets of 30 contractions each), MFM, and a HBE program was more effective than a protocol comprising only IGS with identical parameters, MFM, and HBE in enhancing facial symmetry and alleviating facial disability among patients with Bell's palsy.

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## Conflicts of Interest

No conflicts of interest.

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